MINING ENGINEERING

FEBRUARY 1949

N.E.I. Tin Mining

•

Polish Coal Mining

•

estos Mining and Milling

•

tation of Copper Silicate

A MONTHLY PUBLICATION OF THE
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
MINING BRANCH

EDITORIAL STAFF

EDWARD H. ROBIE
Editorial Director

SECTIONS 1 AND 2

JOHN V. BEALL
Managing Editor

RUTH L. GARRETT
Assistant Editor

HELENE KLEIN
Editorial Assistant

SECTION 3

E. J. KENNEDY, JR.
Managing Editor

DOROTHY G. GARRETT
Editor

BUSINESS STAFF

WHEELER SPACKMAN
Advertising Manager

GRACE PUGSLEY
Production Manager

WALTER J. SEWING
Assistant

AIME STAFF

Acting Secretary EDWARD H. ROBIE

Assistant Treasurer H. A. MALONEY

Assistant Secretaries E. J. KENNEDY, JR., ERNEST KIRKENDALL, WILLAM H. STRANG (Dallas, Texas)

Assistant to the Secretary H. NEWELL APPLETON

AIME OFFICERS

President W. E. WRATHER

Vice-Presidents C. H. BENEDICT, H. J. BROWN, ERLE V. DAVELER, D. H. McLAUGHLIN, R. W. THOMAS

Treasurer ANDREW FLETCHER

TECHNICAL PUBLICATIONS COMMITTEE OFFICERS

Chairman—E. M. WISE

Vice-Chairmen—GEORGE C. HEIKES and GAIL F. MOULTON

Secretary—E. J. KENNEDY, JR.

Auxiliary Publications Committee Chairmen, Mining Branch—

Geology and Mining—ROLLIN A. PALLANCH

Minerals Beneficiation—M. D. HASSIALIS

Coal—H. P. GREENWALD

Industrial Minerals—H. D. KEISER

Mineral Industry Education—CARL TOLMAN

Published monthly by the American Institute of Mining and Metallurgical Engineers, Inc., 29 West 39th St., New York 18, N. Y. Domestic subscription, North, South, and Central America, $8; foreign, $9; to AIME members, $6, or $4 in combination with a subscription to the *Journal of Metals*, or the *Journal of Petroleum Technology*. Single copies, 75 cents. Special issues, $1.50.

Re-entered as second class matter January 18, 1949, at the post office at New York, N. Y., under the Act of March 3, 1879. Registered cable address, AIME. Copyright 1949 by the American Institute of Mining and Metallurgical Engineers, Inc. Printed in U.S.A. MINING ENGINEERING is on file in many public libraries and is indexed in Engineering Index and Industrial Arts Index. Member, Audit Bureau of Circulations.

MINING ENGINEERING

In which is incorporated Mining and Metallurgy, Mining Technology and Coal Technology

FEBRUARY 1949 VOLUME 1, NO. 2

Cover photograph shows a bit of San Francisco, scene of the 1949 Annual Meeting, Feb. 14 to 17.

Section 1

Section 2 AIME

Section 3 Mining Transactions

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, INC.

Mining Branch

Editorial, Advertising, and Business Office

29 West 39th St., New York 18, N. Y.

AIME also publishes Journal of Metals Technology • Practice, and Journal of Petroleum Technology.

NO. 1 First of two advertisements describing Allis-Chalmers equipment for ore beneficiation.

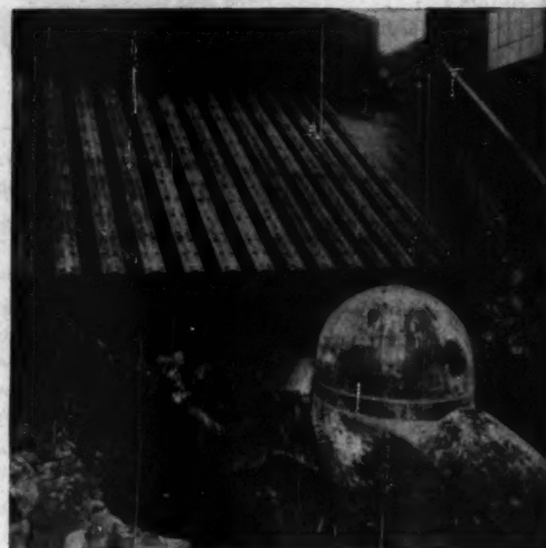
ALLIS-CHALMERS

Low Grade

With Steel Mills Operating at 100% Capacity, Iron Ore Producers are Looking to Beneficiation of Low Grades To Beat Shrinking Ore Supplies. Allis-Chalmers, One of The World's Largest Manufacturers of Ore Reduction Machinery, Furnishes Basic and Auxiliary Equipment for Ore Concentration Plants.

MANY OF THE IRON ORE PREPARATION plants already in operation use Allis-Chalmers equipment to increase production. As three tons of low-grade ores have to be processed to produce one ton of concentrate, producers must step up the scale of mining to make low grades pay off. And that's where Allis-Chalmers can help.

Specialized Allis-Chalmers engineers have studied ore beneficiation methods and equipment from a cost-cutting, tonnage increasing point of view. These specialists guide in the selection of your equipment and help develop new, improved processing equipment.

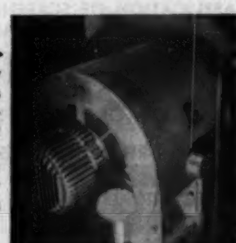


FOR TOP CRUSHING EFFICIENCY, ore producers are using Allis-Chalmers primary, secondary and tertiary crushers. The Superior McCulley crusher, shown above, is used for tough, abrasive, high compressive materials. This type of crusher is now used for crushing taconite.

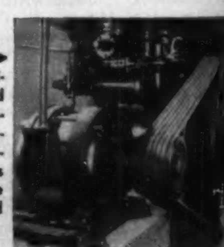
In addition to gyratory type crushers, Allis-Chalmers manufactures a complete line of reduction crushers, jaw crushers, crushing rolls and hammer mills. This means the operator can pick the exact crusher for a particular job, without limitation to size of application.

A-C solids handling pumps were specially designed for simple maintenance. Construction is of abrasive-resistant material adapted to metal mining and process industries.

Motors for main and auxiliary drives, generators and control equipment are supplied by Allis-Chalmers. Sizes range from one horsepower for both a-c or d-c service.



Texrope drives are shock-absorbing, compact and economical. Allis-Chalmers, originator of multiple V-belt drives, offers engineering advice with unparalleled drive experience.

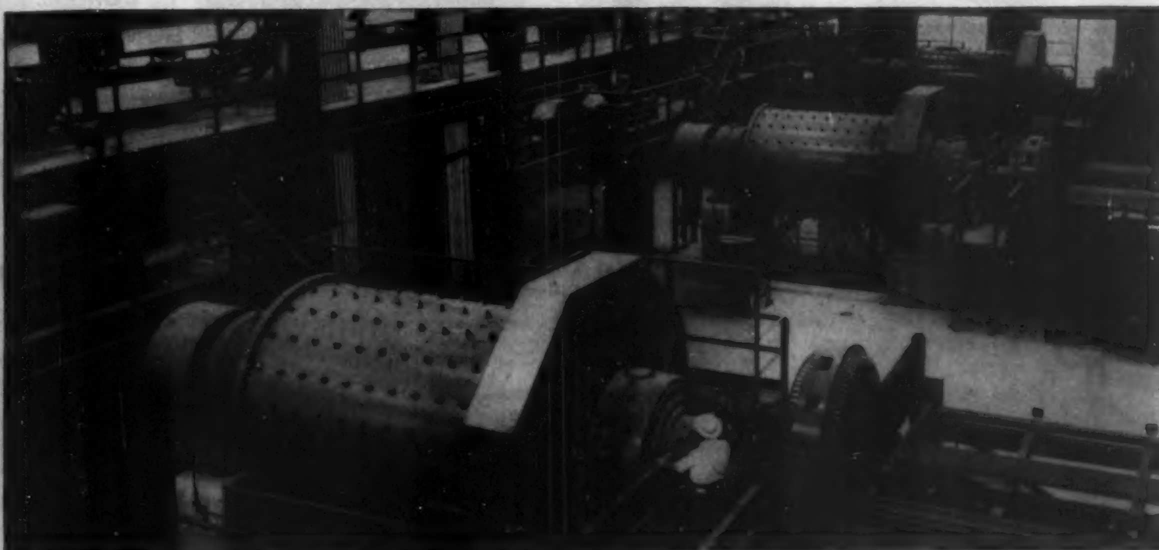


Power, Electrical, Processing Equipment for Iron and Steel

ALLIS-

BUILDS EQUIPMENT TO MAKE

Ores Pay Off



ROD MILLS ARE ONE OF FIVE separate types of grinding mills built by Allis-Chalmers. The three 8′ x 12′ A-C rod mills shown above are an outstanding installation in the Adirondack iron development. A-C builds grinding mills of the rod and ball types in sizes from 3′ to 10½′ diameter, 3′ to 16′ lengths.

Metallurgical, mining and chemical engineers have worked together at Allis-Chalmers to develop mills for any grinding problem. Only Allis-Chalmers manufactures all the related equipment to power and control this ore reduction machinery. Operators get a completely co-ordinated installation with undivided Allis-Chalmers responsibility.

IT IS IMPORTANT that you consider future processing equipment needs NOW. An Allis-Chalmers representative can tell you more about the complete line of ore beneficiation equipment. Call Allis-Chalmers district office or write direct.

A-C builds turbo-blowers for converter or furnace blowing and ore flotation. Blowers are supplied in capacities up to 130,000 cfm at pressures from 1 to 35 lb G. ▶

A-1 and Texrope are Allis-Chalmers Trademarks.

ALLIS-CHALMERS BUILDS EQUIP

Low Grade Ores

The second advertisement describing Allis-Chalmers equipment for ore beneficiation will be published next month. Send coupon below for reprints of the two advertisements.

ALLIS-CHALMERS, 971A SO. 70 ST. MILWAUKEE, WIS.

Please send advertisement reprints on Allis-Chalmers ore beneficiation equipment.

Name ____________

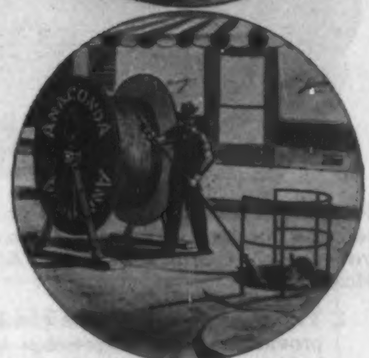
Title ____________

Company ____________

Address ____________ A 2605

ALLIS-CHALMERS MILWAUKEE A-C

CHALMERS


ANACONDA

MORE SAFETY

Gardner - Denver Model H K K Safety Hoist

Four important safety features protect the operator and the load when you choose a Gardner-Denver Air Hoist:

1. Two piston rings on each piston provide enough compression to hold a maximum load almost stationary.
2. A powerful, oversize band brake with quick adjustable take-up holds any load in suspension.
3. The Splined Clutch has a self-locking latch which cannot be disengaged unintentionally.
4. The single throttle lever automatically returns to neutral when released.

Other features of Gardner-Denver Air Hoists:

SPEED —*5-cylinder radial air motor handles capacity loads quickly. Overlap of power impulses greater than on an 8-cylinder automobile engine.*

SIMPLICITY —*single throttle lever operates hoist in either direction.*

LONG LIFE —*completely sealed gear train keeps oil sealed in, water and dirt sealed out. Three-point lubrication of all moving parts.*

GARDNER-DENVER SINCE 1859

For complete information, write Gardner-Denver Company, Quincy, Illinois

JOY-AMSCO SLUSHING SCRAPER

Equal

TO YOUR TOUGHEST JOB

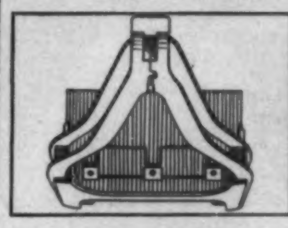
Have you checked the Joy-Amsco slushing scraper point-for-point? You'll find it's designed in detail to meet every abusive condition that a mucking job can present. And design is backed up by making all parts of Amsco Manganese Steel . . . the one super-tough steel that gets more wear resistant, the more battering your work imposes. Before you buy, obtain all the facts on the Joy-Amsco slushing scraper. It's built to haul bigger loads, to dig-in faster, and stay on the job longer.

FOUR TYPES . . . TWENTY-EIGHT SIZES

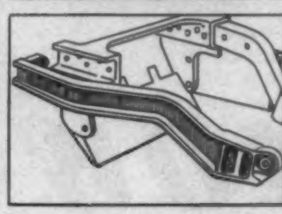
Joy-Amsco slushing scrapers are built as standard or one-quarter box, half, full, and hoe type scrapers. Each type is available in seven sizes from 36" to 72".

FOR COMPLETE INFORMATION WRITE
JOY MANUFACTURING COMPANY
PITTSBURGH • PENNSYLVANIA
or the Joy regional office nearest you

DESIGN FEATURES

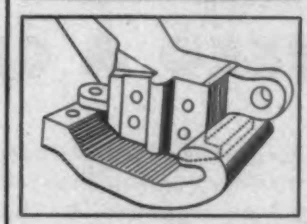


OPEN YOKE
. . . no cross bars to hang on large boulders and lift scraper off load



TAPER FIT
. . . puts tug load on arm and body castings — takes stress off bolts

SHOE KEY
. . . locks position of arms at front —prevents misalignment of arms under load



INTERLOCKING FITS
. . . provide one-piece rigidity. Wherever castings join, such as lip and body, taper joint design interlocks scraper into a solid unit

BOLT GUARDS
. . . all bolts are either recessed in or shielded by protecting ribs . . . eliminating peening or other damage in use

AMERICAN **Brake Shoe** COMPANY

AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS, ILL.

Foundries at Chicago Heights, Ill., New Castle, Del., Denver, Colo., Oakland, Calif., Los Angeles, Calif., St. Louis, Mo.
Offices in principal cities. In Canada: Joliette Steel Limited, Joliette, Que.

EXAMPLE 1 Tailings losses have been lowered and concentrate grade doubled at a large copper concentrator by using .08 lb. per ton of Reagent 404 with .03 lb. per ton of Reagent 301 as promoters, and by regrinding the rougher flotation concentrate. Concentrate grade has been raised from 14.252 to 30.665% and the tailing loss has ben decreased from 0.252 to 0.185%.

EXAMPLE 2 Dilution with alabandite (MnS) caused difficulty in maintaining grade on a lead-zinc ore. Sodium cyanide and potassium permanganate were used to depress the sphalerite while the alabandite was floated with a mixture of pine oil and cresylic acid as a frother, thus raising the grade of zinc concentrate from 45% Zn to 52% Zn.

EXAMPLE 3 Merely by changing to Sodium Aerofloat* "B", a custom-mill treating lead-zinc ores raised the grade of zinc concentrate from 46% to 54% Zn.

EXAMPLE 4 Barite ores containing fluorite proved extremely difficult to treat because of the similar flotability of the two minerals. Cyanamid Mineral Dressing Laboratory found that selectivity could be achieved by using sodium silicate and barium chloride to depress fluorspar. Barite is floated with Reagent 825. By the use of this reagent combination, 90% of the barite is recovered in a 98.5% $BaSO_4$ concentrate containing 0.096 CaF_2 from an ore assaying 84% $BaSO_4$ and 7% CaF_2. Tailing contained 45% CaF_2.

EXAMPLE 5 A large flotation plant treating a manganese ore (rhodochrosite) found that substitution of Reagent 825 for one-half of the fatty acid soap, reduced total promoter consumption by one-third. The type of froth produced by the new promoter combination results in smoother and more uniform plant operation. Lower tails are obtained with a decrease in reagent cost—a double dividend!

EXAMPLE 6 When the pyrite in the mill feed increased, a lead-zinc flotation plant in the Western U. S. began to have trouble with zinc concentrate grade. All of the well-known zinc promoters were tried. Finally Aerofloat* Flotation Reagent 226 was put on the mill. Only 0.06 pounds per ton in the form of a 10% solution added to the third conditioning, after the lime and copper sulfate, has produced acceptable grade.

EXAMPLE 7 Having trouble with lime scale in your solution lines? Experiencing lime deposition on the filter cloths in your cyanide plant? The Cyanamid Mineral Dressing Laboratory finds that complex phosphates, such as sodium tetraphosphate ($Na_6P_4O_{13}$) act as "sequestering agents" preventing lime deposition, thus greatly increasing the life of filter cloth. A surprisingly small amount is effective . . . as little as 10 pounds per day per 2,000 tons of solution . . . 0.005 pounds per ton!

EXAMPLE 8 In Heavy-Media Separation (Sink-Float) Processes, magnetic medium has been found superior to all others. Two large Heavy-Media plants which formerly used galena have now converted to ferrosilicon with better grade of concentrate and lower tails. A third plant will convert in 1949. Ferrosilicon is considerably cheaper than galena. It is also easier and cheaper to clean and keep clean, thus making it possible to operate at higher gravities when necessary. One plant treating barite ore operates at 3.75 specific gravity! Slimy ores present no problem. One Heavy-Media Separation operator writes "Chief virtue of ferrosilicon is in the ease of cleaning. Some of the muddy ore now being received at our mill would be extremely difficult to handle with galena as a medium."

*Aerofloat is a registered trademark of American Cyanamid Co. applied to certain flotation reagents of its manufacture.

★ ★ ★ ★

In your check-up of milling and treatment methods, Cyanamid Field Engineers and the Cyanamid Mineral Dressing Laboratory stand ready to help you make the most efficient use of chemical reagents and Separation Processes by Gravity Difference. An unbiased review of your present beneficiation practice may reveal worthwhile opportunities to increase recovery, cut costs or expand output. Starting point is a discussion of your current metallurgy and ultimate objectives. We invite correspondence.

Part of Cyanamid Service to Metallurgy is MINERAL DRESSING NOTES, a publication of the Cyanamid Mineral Dressing Laboratory issued whenever new technical data on reagents and processes become available. If you would like to receive these helpful bulletins, kindly fill out the coupon below.

Name ______________________

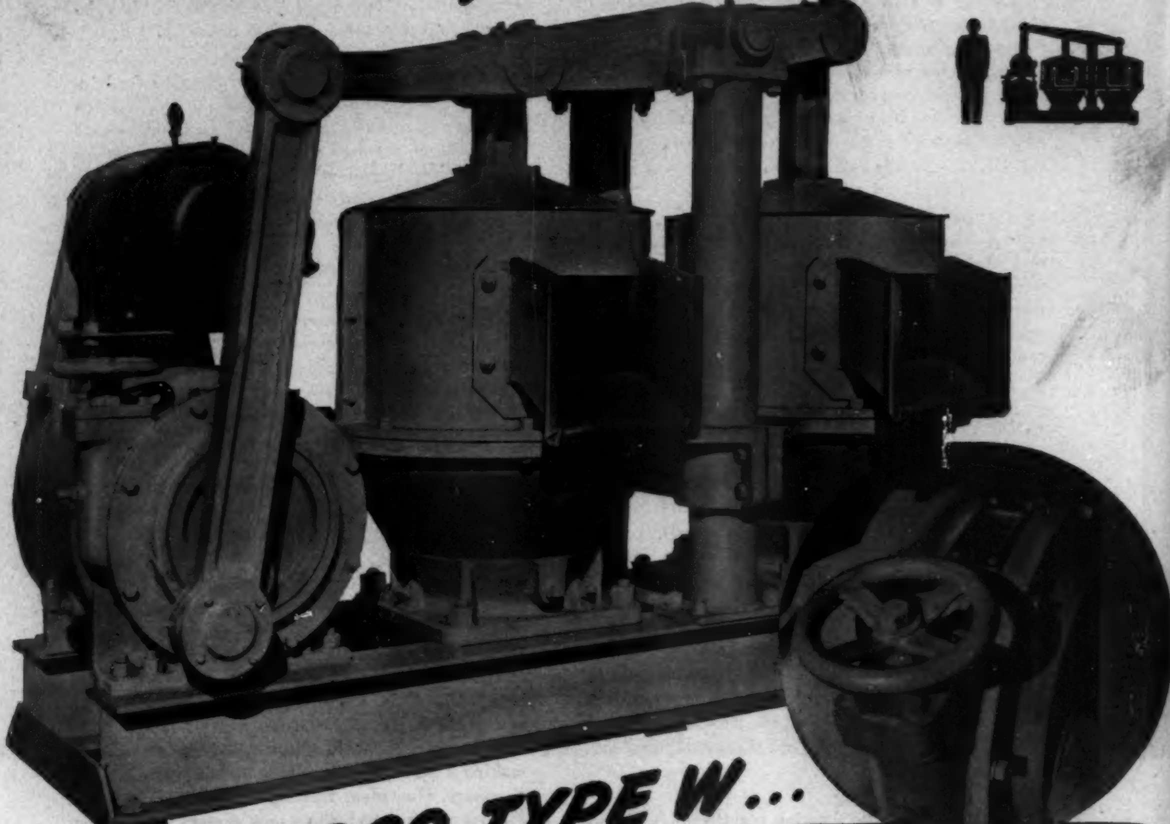
Company ______________________

Address ______________________

30 ROCKEFELLER PLAZA,
NEW YORK 20, N.Y.

Printed in U.S.A.

Man-size pump... for man-size pumping jobs



Closeup of stroke adjustment handwheel. Note calibrated stroke indicator.

THE DORRCO TYPE W...

Newest addition to the Dorrco line of diaphragm pumps is the Type W... a rugged giant designed for big tonnage work.

√ **STROKE ADJUSTMENT WHILE RUNNING**... Plunger stroke can be varied by an easy turn of the stroke adjustment handwheel, varying discharge rate within a 6 to 1 range... *while pump is in operation.*

√ **BIG CAPACITY**... An 8" duplex pump, the Type W will handle up to 75 cubic feet per minute of pulp.

√ **HIGH MECHANICAL EFFICIENCY**... Cranks and ball bearings are used instead of power-consuming eccentrics and low efficiency sleeve bearings.

√ **QUICK DIAPHRAGM REPLACEMENT**... Diaphragms are of beaded construction for fast and easy replacement.

√ **MINIMUM LUBRICATION REQUIRED**... Oilite bushings and anti-friction, grease-lubricated bearings are used throughout.

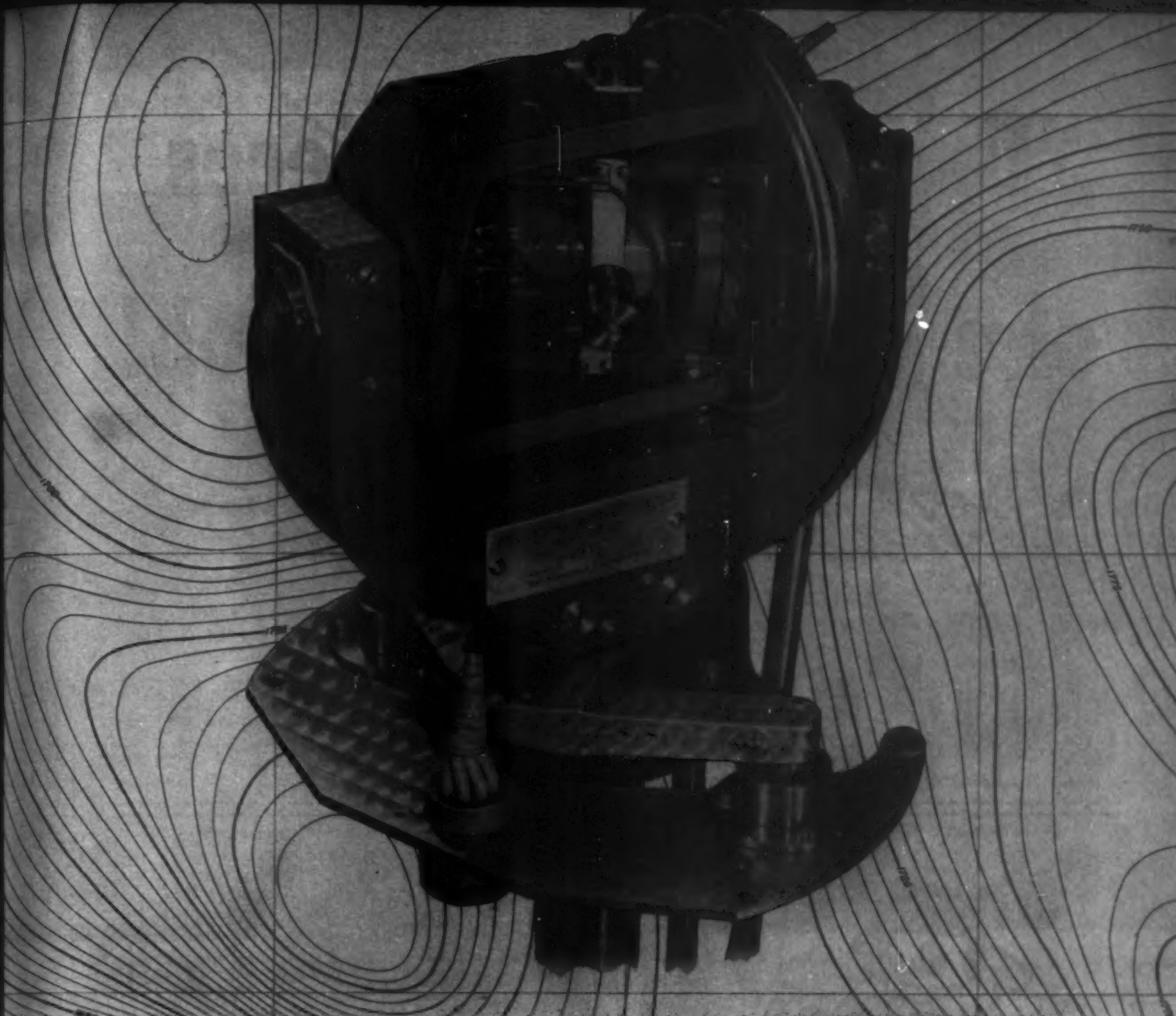
Applicable on Hydroseparator or Thickener underflows... wherever big tonnages, big flows or heavy pulps are involved ... the Dorrco Type W is rugged, compact and highly flexible. A Dorr engineer will gladly supply more specific information... without obligation.

DORR

RESEARCH ENGINEERING EQUIPMENT

DORRCO

THE DORR COMPANY, ENGINEERS
570 LEXINGTON AVE., NEW YORK 22, N. Y.
ATLANTA • TORONTO • CHICAGO
DENVER • LOS ANGELES
RESEARCH AND TESTING LABORATORIES
WESTPORT, CONN.
SUGAR PROCESSING
PETREE & DORR DIVISION, NEW YORK 22, N. Y.
ASSOCIATES AND REPRESENTATIVES
Dorr Technical Services and Equipment Are Also Available Through Associated Companies and Representatives in the Principal Cities of the World. Names and Addresses on Request.



NOW AT WORK IN AFRICA—AVAILABLE FOR SURVEYS *ANYWHERE*

The airborne magnetometer, now at work in Africa, is available for your explorations *anywhere*.

In AERO's experienced hands, the Gulf high-sensitivity instrument brings a new utility to aerial magnetics. Our surveys deliver magnetic data of a high order of accuracy—collected speedily and at lowest cost.

From its five years' pioneering experience* AERO brings solid answers to your exploration questions. Facts about survey schedules and costs . . . about the established performance of the airborne magnetometer . . . are yours for the asking. Our invitation to discuss the airborne magnetometer's application to your exploration plans involves no commitment. Write today.

*In Canada, United States, Cuba, Africa and over water in the Bahamas

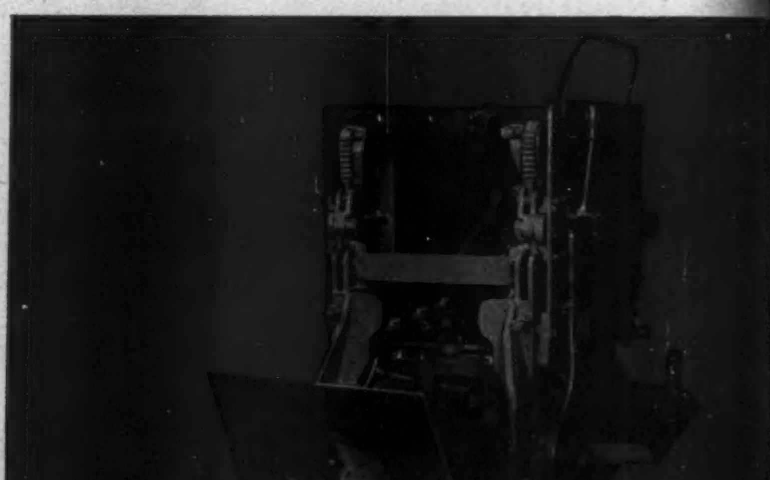
AERO SERVICE CORPORATION
236 E. COURTLAND ST., PHILA. 20, PA.
Oldest Flying Corporation in the World

PHOTOGRAPHY • COLOR PHOTOGRAPHY • PRECISE AERIAL MOSAICS • AIRBORNE MAGNETOMETER SURVEYS • PLANIMETRIC MAPS • TOPOGRAPHIC MAPS • RELIEF MODELS

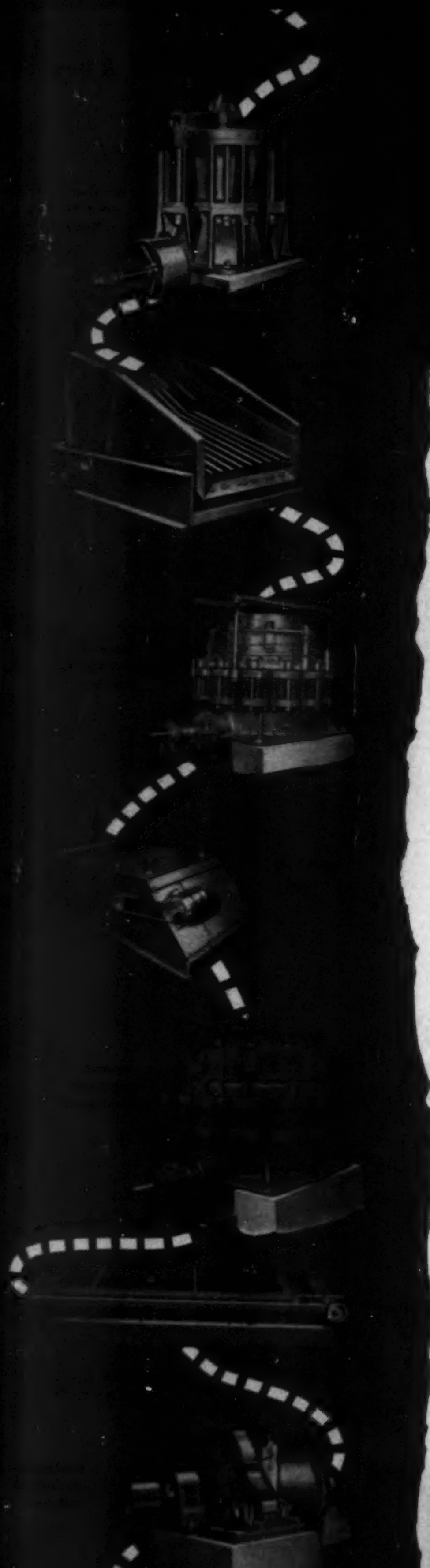
"One of the best pieces of equipment on the job!"

That's what users say about

JOY SHOVEL LOADERS



The JOY HL-20 Shovel Loader for large drifts. Can load up to 3 tons per minute using cars from 50 to 90 cu. feet capacity.



GEOMINES SELECTS NORDBERG EQUIPMENT

all the way

from Primary Crushing to Final Grinding

One of the outstanding mining developments is the new processing plant of Compagnie Geologique et Miniere des Ingenieurs et Industriels Belges Soc. Anon (GEOMINES) in Belgian Congo. Nordberg equipment was selected for every step in processing ore from the mine until it was ready for concentration.

This equipment includes a Nordberg Gyratory for primary crushing, Vibrating Bar Grizzly, Symons Standard Cones for second stage crushing, Rod Deck Screens, Symons Short Head Cones for third stage crushing, Symons Horizontal Vibrating Screens and Nordberg Grinding Mills. Here is another of the world's outstanding mines where Nordberg equipment is being used for processing of ores.

PRIMARY CRUSHING

Nordberg heavy duty Gyratory and Jaw Crushers are furnished in various types and sizes.

SIZING AND SCREENING

Sizing and screening equipment can be supplied for wet or dry operations in any desired capacity or separation. The types include Vibrating Bar Grizzlies, Horizontal Vibrating Screens and Rod Deck Screens.

SECONDARY CRUSHING

Symons Standard, Short Head and Intermediate Cone Crushers cover the entire range of fine reduction crushing operations. A wide variation of sizes are furnished to fit your requirements of feed, product and tonnage. Large capacity of fine products is an outstanding feature.

GRINDING

Complete line of heavy, rugged Grinding Mills available in sizes up to 10' 8" diameter and 50' 0" long. Ball, tube, rod and compartment mills are offered in the larger sizes for wet and dry grinding.

Write for literature on the equipment you need.

NORDBERG MFG. CO.

NEW YORK • SAN FRANCISCO • WASHINGTON • MEXICO D. F. • LONDON • TORONTO • JOHANNESBURG

MI 49

MINING ENGINEERING

Advanced Degrees and the Mining Engineer

While busy exercising the divine powers of editorship the other day we were interrupted by the appearance of a stalwart young man who informed us that he was a Doctor of Mining Engineering and that he was looking for a job (fresh out of school) and could we help him. As it took a moment for this to sink in, we gave him the "double take" (made famous by Bob Hope) as we had never seen a Doctor of Mining Engineering under 50 before. After the young man left with the names of a few firms to approach, we tried to visualize this man with six to seven years of higher education behind him wielding a muck stick to get his start, as we have heard advocated by some; possibly grabbing muck samples or better yet cutting channel samples in a gold-quartz vein—*that* really takes a Ph.D.; or maybe running a transit. Just what would a mining company do with such a man, with no practical experience?

We remember a visit we had with Curtis Pigott who, as assistant manager of the Laurel Hill smelter of the Phelps Dodge Corp., does a swell job of recovering copper from a heterogeneous mass of copper and brass scrap, and we know he graduated in *mining* back around the turn of the century. He will tell you that when he went to school a mining engineer could do anything—prospecting, mining, milling, and smelting. Nowadays the metal mining business is broken down into specialties. We have mining engineers, ore-dressing engineers, and metallurgists each of whom is trained to handle one phase of the operation that formerly was covered in one course—mining engineering.

We know that many companies maintain highly trained and specialized staffs of researchers in beneficiation and metallurgy but what do they have for men with advanced degrees in mining? Are the existing mining methods the best ways to win metal ores from the earth? Do you have to drill holes and load them with powder to extract ore? Must ore be lifted to the surface by hoisting? We've heard tell of a supersonic vibration machine that might shake crystalline ores like potash loose from their natural state. We've also heard of the idea of lifting rock by means of a column of liquid of greater density than the ore. Possibly more economic means of loading and haulage could be devised if the right people were assigned to study the problem. It is likely that many of these research problems might better be entrusted to other types of engineers than mining engineers. What then is the job of the mining engineer and how much college training does he need? Maybe the mining industry only needs technicians or combination technicians and businessmen. We don't think so, but who is going to encourage these young men to take graduate training and provide jobs that will use this knowledge when they have it?

A Market for Waste Rock?

Finding a market for all possible by-products has often meant the difference between a profit and a loss for companies in a great variety of fields. The meat packers, for instance, have long been known as utilizing everything but the squeal of the hog. Mines, mills, and smelters all throw away much of the material that they extract from the ground or treat: the waste rock or overburden from mines, finely ground tailings from the milling plants, and red-hot slag and sulphur dioxide from smelters. Some sulphuric acid is recovered from the last-named, but for the most part all of these are waste products.

In some instances, a market might be found for some of these materials, and perhaps an idea or two might be gained from perusal of a bulletin just issued by the National Bureau of Standards called Simplified Practice Recommendation R163-48, Coarse Aggregates (ten cents from the Government Printing Office). It deals with the sizes of crushed stone, gravel, slag, and coarse aggregates for road building, airport construction, and similar uses, and includes a table of typical uses for each of the listed sizes. This is a revision of a former useful bulletin, listing certain new marketable sizes and changing the limits of others. Sizes of aggregates for sewage trickling filter media have been added.

Student Associate Plan

With the new publishing program, the dues for Student Associates had to be revised. Following establishment of the nonmember subscription rate of $8 to the new journals, it was necessary to set a subscription rate of not less than half that amount for Members and Student Associates if second-class postage rates were to be enjoyed. This meant that Student Associates must pay at least $4 for their subscription to a journal; and a nominal fee of fifty cents for their other privileges was set, making the total $4.50. Many educators, and others close to students' problems, felt that, with all their other costs rising, an increase in Student Associate dues would cause them considerable hardship; and some even asserted that the AIME would lose most of its Student Associates if the new fee were levied. An opposing group felt that increased costs were general and expected with our devalued dollar, and that $4.50, which means less than the cost of one movie or three packages of cigarettes a month is not excessive.

A happy solution was finally reached. Those students who wish individual copies of one of the journals, and can afford the $4.50 a year, will pay that amount. Those who must count every cent of their expenditures, and who can get along with a library copy of the monthly journals, need pay but $2. Subscriptions will be provided to Affiliated Student Societies, on request, for group use.

Leaching of Low-Grade Nitrate

Since the discovery of a commercial process for making synthetic nitrates a couple of generations ago, the Chilean nitrate industry has not been so important or so profitable as it once was. Not only has it lost its monopoly for this essential fertilizer and ingredient of explosives, but its high-grade deposits, which used to contain something like 40 to 45 per cent of nitrate, have been worked out and the average now is said to be about 8½ per cent, with 7 per cent as the limit for profitable operation. The Guggenheims are still the dominant interests in nitrate in that country, accounting for about three quarters of Chilean production.

A rocky residue containing about 1.3 per cent of nitrate is a waste product, and at the Pedro Valdivia plant there is a huge dump of this material amounting to some 100,000,000 tons, or 1,300,000 tons of nitrate.

Now, according to a dispatch to *The New York Times*, plans are being made to treat this material by using the God-given heat of the desert sun. The residue will be leached with water, which will then go to seventy ponds, each with an area of some 410,000 sq ft, with the solution only about 1½ ft deep. Solar evaporation will eliminate the large volume of water, which heretofore made treatment unprofitable, and will provide a concentrated liquor containing the nitrate and accompanying salts. Although the plants are situated in a desert, brackish river water is available in ample quantity for the proposed leaching. None of it will be recovered in rain.

Public Relations and the Mining Industry

Recently we have received some press releases on topics which are usual enough, but which are not so commonplace when one considers the source from which they emanate. Not many mining companies take the trouble to publicize the fact that low-cost loans are made available by the company for employe housing; that Christmas music is broadcast by loudspeakers at the community center by courtesy of the company; that increased pensions are being paid by the company to aid retired employes through this period of inflation; and that the company is building a sports area; all these are described by The Consolidated Mining and Smelting Co. of Canada in recent press releases. Such publicity would appear to make for excellent employe and public relations.

To be sure we have heard over the radio how some companies boast of the number of home owners they employ, the number of forty-year service men, and how happy their employes are. We see house organs that keep workers posted on the positions of their own softball teams, the new babies, and weddings within the fold of company employes. As a matter of fact we have seen movies that show the worker on the job and demonstrate to him how the job he does is an essential part of the whole organization which builds and adds to the prosperity of America. It seems that these are all part of the job of public relations.

Some benefit must accrue to the company that goes in for this sort of publicity. We think it might be profitable if the public knew that long service to a mining company was rewarded, that working conditions underground can be pleasant, that mining is no longer strictly a pick-and-shovel job, that miners own their own homes, and that their children go to college. It seems to us that Consolidated is leading the way into a field in which every sizeable mining company can reap a reward and the sooner they get started the better. Congratulations, Consolidated.

N. E. I. Tin Mining Resumed

By J. VAN DEN BERG • MINING ENGINEER; MEMBER, AIME

This is the dramatic story of the Billiton Co.'s return after the war to the tin islands of Billiton, Banka, and Singkep in the Netherlands East Indies. Although many hardships were encountered, because of the occupation of the Japanese who had ruined much of the mining equipment and impoverished the natives, the natives welcomed the return of the Company and, for the most part, labor relations have been harmonious. Although production was rapidly being restored and the outlook was apparently bright, recent political developments are foreboding. Mr. Van den Berg wrote this article for ME in the fall of 1948 before these developments.

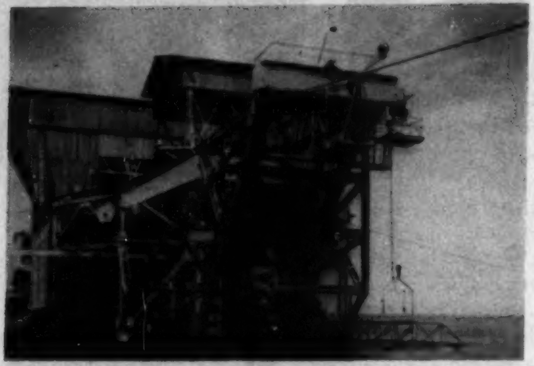
Tin production and export from the Far East are still a long way off from the prewar figures. The Malayan Peninsula, which had a rather good start directly after the war largely because of stock piles found in Singapore and elsewhere, has since been hampered in the rehabilitation of its tin mines and dredging operations by material shortages and, more recently and more severely, by revolts and attacks of communist elements and gangster bands. These hindrances make working in the mines dangerous and form a daily threat against the valuable and highly vulnerable dredges.

Contrary to the conditions in Malaya are those on the tin islands of Billiton, Banka, and Singkep—all in the Netherlands East Indies—where the Dutch have re-established peaceful relations with the population. Dutch efforts since the fall of 1945 have been rewarded by continuously increasing production, extension of production facilities, and return of moderate prosperity, complete safety, and all-out co-operation among the population—native and Chinese—to the benefit of all concerned.

Current tin production on the three islands is approximately 35,000 long tons a year, a rate that is higher than the average one of the thirties. A further increase may well be expected since Banka, the island with the greatest potentiality, recently came under the management of a private corporation, the Billiton Co., which should expedite operations.

The Billiton enterprise was started in 1850 by three prominent Netherlanders, one of whom, Prince Hendrik, was the brother of the king ruling at that time. While Banka, under the N.E.I. Government, had been producing tin for more than a century, the island of Billiton had remained *terra incognita*, as far as tin was concerned. A party sent to Billiton by the Government in 1849 had, after a short time of prospecting, reported that no tin deposits of any value might be expected there. In spite of this verdict and the island's inhabitants—pirates and dangerous aborigines—the three individuals' spirit of enterprise prevailed.

Although tin definitely was found by the pioneers in 1851, a hard time came for those men. Of the twelve European employes engaged from 1852 to 1855, only five survived; diseases, such as malaria and dysentery, claimed some and murder a few more. In addition, labor had to be imported from Singapore, as the natives were



Famous Karimata dredge, which produced over 1000 tons of tin concentrate containing about 800 long tons of metallic tin in one record month, digging for tin ore along the coast of Billiton island. This dredge was built in Holland in 1936.

Banka exploration drills make a 6-in. hole using aluminum rods. Platforms are floated on oil-drum pontoons. Offshore drilling, as shown here, near Klappa Kampit, is only possible during the few quiet months of the east monsoon.

Manggar power station as it looked prior to the Japanese occupation. Of its prewar capacity of 22,000 hp, only 50 hp was left intact when the Dutch returned to the islands in October 1945; most of the engines being shipped elsewhere by the Japs.

not accustomed to digging pits, and operations were primitive. It seemed that the tin content of the soil hardly paid for the high cost of production. After about eight years of strenuous efforts the pioneers, not able to borrow money to continue operations, had to sell out. Thereupon, in 1860, the Billiton Co. was formed.

The first years of this new enterprise were difficult because of a drop in the price of tin and a shortage of equipment due to insufficient working capital. But after 1868, the introduction of the Akkringa prospecting drill, the discovery of richer deposits, and the rapid influx of mine workers from China, followed by some mechanization, turned the chances. Yearly production increased from approximately 200 tons in 1860 to about 3000 tons in 1870, and 6000 tons in 1890.

The native population, which before contact with white men lived from farming, fishing, and piracy, increased under the better living conditions provided by the Company from 10,000 in 1860 to about 40,000 in the beginning of this century. The Chinese population, mostly by direct immigration from China, increased from about 600 to 20,000 in that same period. In 1941 the total population amounted to approximately 90,000. These figures show clearly the influence of better living conditions brought about by the introduction of foreign capital.

When the Japanese entered they found complete harmony between natives, Chinese, and Europeans; grade schools and training schools for crafts; swimming pools, soccer fields, and permanent housing; Chinese singing on their way to the mine or dredge; and natives with smiles in their deep brown eyes.

I had known those conditions for about fourteen years, working there before the war. Hence, I was rather surprised, upon my return to Batavia in October 1945, by the high officials who said it was impossible to continue my trip to the tin islands because they were in an uproar that could be pacified only by an army. As the situation on Java had to be cleared first, it would be impossible for our party to visit the islands and report on the condition of the mines and dredges.

Matters on Java went from bad to worse, leaving our party in an awkward situation. But we decided not to give up without trying. We put our personal knowledge of the population and its friendliness towards the Company above the advice of the authorities and followed a course of knocking at each prominent door in Batavia.

After ten days' search for assistance, we made a strike. A personal friend, a Dutch Navy Captain in Admiral Helfrich's office, was allowed by the British High Command to appoint passengers for the Dutch Catalina flying boats of the Batavia-Singapore service. No intermediate landings were permitted. We were satisfied though, for we would be able to observe the land, dredges, and mines from the air.

We started off for Singapore the next morning, with no other passengers on board. When we were over Billiton, approaching the mines and dredges, the pilot dropped us to a lower altitude and circled his plane around all the important points of our operations. In the villages, people started waving at us. As we flew over the capital, Tandjong Tandan, people crowded the streets, looking and waving at us. Ours was the first Dutch plane they

had seen in about four years, since most of the aircraft were lost in fighting over Malaya. The pilot, for some reason, had to make an emergency landing on the wide river Tjiroetjoek. The crowd, called dangerous and rebellious by the authorities in Batavia, gathered at the landing pier in thousands. Some of them loosened their boats and canoes and paddled quickly towards the plane. When they recognized our party, tears flowed from their friendly Chinese and native eyes. They dragged us from the plane, into their boats, and rushed us to shore where the crowd was waiting. Once ashore, there was no end to handshakes, nose kissing, and embraces. Without any weapons we had landed among people for whom, according to the officials, an army would be needed. Their first question was "We have been looking out for more than six weeks for your return; where have you been all this time?" A few low-bowing Japanese soldiers eventually made room for us and, at the shore end of the pier, a band started to play the Dutch national anthem.

In honor of the return of the Billiton Co., there was a great dinner party with *rijsttafel* and such Chinese delicacies as suckling pig, Chinese hors d'oeuvres, and shark-fin soup. Best of all were the genuine prewar French brandy and the finest of prewar Dutch cigars that had been saved for more than three years for this special occasion. Many an old friend sneaked in during the dinner to shake hands, express his gratitude, and bring us news about the terrible past and the condition of the mines, workshops, and power stations. We heard a story of hunger and hard work, and of how many good men died or were carried away to unknown destinations. There were no textiles for clothing. The fishermen had no sails for their boats, or thread or hooks for their lines. All prewar prosperity had vanished. A similar story was told about the bad condition of the roads, dredges, and flooded mines. The main Diesel power station, with a prewar capacity of 22,000 hp, had been dismantled and its parts shipped off; only 50 hp could now be produced. However, the European houses had been cleaned and restored, as much as possible, soon after VJ day. More stories were told about sores, malaria, and other diseases. But, throughout the evening the population's spirit—its desire to help restore the enterprise, and its faith in the return of prosperity and health under the Company's guidance—prevailed.

The job started by the pioneers ninety years ago had been well done; neither war nor political slogans against capitalism could ever completely destroy free enterprise as long as its benefits were appreciated by the people themselves. It is remarkable how much more the Malay and Chinese care for, and go by, facts rather than mere political phrases and promises. Their almost unlimited confidence in their old employers, the officers of the Company, is striking.

We never went to Singapore, but returned, the same afternoon, to Batavia. There, with a Billiton representative for proof, we reported our adventure to Lt. Governor Van Mook, who was much surprised. The other officials, who had talked about the necessity of an army, reacted similarly. The next day, the jubilant Admiral Helfrich arranged for "Tromp," a valiant vessel, to set out for Billiton, carrying doctors, nurses, medical supplies, government officials, and a small military detachment.

After the official surrender by the Japs on board the "Tromp," we went ashore and the job of rehabilitation was started. It was not an easy job. At the outset our assets were 300 tons of tin in concentrate, found in the store house, and the co-operation of the population.

The opencast mines were all flooded; millions of gallons of water would have to be pumped out. But most of the pumps were in disorder, the electric motors that had not been carried off were damaged, and only 50 Diesel hp was available. On the other hand, the mechanical and electrical workshops were still in rather good shape, the warehouses contained some valuable spare parts, and a few cars were in running condition. These resources enabled us to make a quick survey of the dredges and mines and expedited the repair of ordinary equipment. All the dredges were still afloat, but most were deplorably worn-out. The steam engines of the wood-burning dredges had been taken off to provide an independent power station in the woods. However, the cylinders were in a damaged condition because of the lubricating oil the Japs had used for the engines. This lubricant was prepared by boiling coconut oil with damar, a local resin, until the mixture had the right S.A.E. But the Japs soon found out that the right S.A.E. is not the only requirement for a good lubricating oil.

After six months' hard work the dredges began operations. First came the self-contained wood-burning dredges; they were followed by other 7-cu ft dredges which had to rely on their own power rather than that of the now decimated main station. Fortunately, a shipment of about twenty 75kw General Motors Diesel electric plants, ordered before we left the United States, arrived and could be operated in a team on board the dredges or in a shore station close by.

In the meantime, some of the main Diesel engines were repaired and put in operation, producing sufficient electric power to start pumping out the opencast mines in the eastern part of the island. The pumping installations on these large-scale hydraulic mines are equipped with three 150-hp pressure pumps and three 300-hp 12-in. gravel pumps driven by 3000-v a-c motors. It required about three months' pumping to empty the pits.

Pending the arrival of modern equipment, a few hydraulic mines were started using prewar wood-fired steam engines with belt-driven pumps of small capacity. But the rehabilitation of the dredges required so much of the available man power that only some of these mines could be worked. It takes a lot of labor to cut the wood, and then five months for seasoning it.

About a year passed before adequate supplies—such as steel, welding rods, steel pipes, Diesel engines, and pumps—started to arrive. In the meantime, however, the management had plenty of other problems, of which the most important was the requisition of rice, clothing, and other domestic necessities for about 10,000 employes and their families.

An example of the confidence shown by the population in the Billiton Co. was the acceptance of paper money issued by the Company. When we started reopening the mines, the Government could supply us only with money in denominations of 50 cents and greater. The

Unloading semiconcentrates at a small concentrator where the material is jigged, tabled, and, if necessary, further cleaned by magnetic separators to remove the associated minerals ilmenite, monazite, and magnetite.

Arriving from Holland this 14-cu ft dredge was towed for three months by a 2000-hp tug from the icy waters of the North Sea, through the Suez Canal, to the warm green waters surrounding the island of Billiton.

useful pennies, nickels, dimes, and quarters were not available. The only way out was to make this kind of money ourselves. Thousands of little slips were stamped by hand and were accepted by the workers and the stores.

The highly inflated cost of living, one of the main problems, had to be met. This inflation was due to a severe shortage of rice, sugar, and all kinds of materials in a land that had been completely depleted by the invading Japanese. Prices were more than ten times above the prewar figures. Elsewhere in the Indies, however, this figure was still higher, and in the neighboring island of Banka it was over twenty times. To combat the inflation, the Company, as before the war, gave free rice to its workers. Bound by Government restrictions, the quantity had to be somewhat lower than the prewar allotment of 66 lb per month for bachelors and 132 lb for married workers per month, but the caloric value of the rice supplied was adequate and about fifty per cent higher than elsewhere. In addition, about twenty to thirty different articles, such as dried fish, lard, canned milk, coconut oil, cigarettes, salt, sugar, tea, and coffee, were distributed in adequate quantities at prewar prices. There being little to buy on the free market, the miner's take-home pay, with reasonable extras for children and increased expenses, amounted to almost double the prewar figure and was sufficient for his needs. Officials of the department of labor and Chinese authorities, familiar with conditions in other parts of Asia, praised this system as the best seen since the war.

However, the Chinese labor union, guided by some radical intellectuals who had been educated in Singapore and who had never actually worked in the mines, demanded higher wages. Experience with recent increases, which only increased prices on the free market, made the management refuse to give in. A strike was called and lasted for three months. Most of the Chinese workers were against the strike, but fear of severe measures taken against their families and homes made them stay away from their jobs. Because the Chinese—the most experienced in mining—did so, a serious situation arose. However, the Malay labor union, disregarding pressure from the Chinese union, decided to work. After a few weeks' trial, many of the natives turned out to be good winch drivers and were capable of taking over practically all mining jobs previously held by the Chinese. When the union gave in, the Chinese workers returned to their jobs in better spirits than before. Since that date, August 1947, production has steadily increased, and by the end of the 1947 fiscal year the Company reported that the rehabilitation of the alluvial mines was complete. At the time, fourteen bucket dredges, two suction dredges, two large hydraulic mines, and eighteen small hydraulic mines were in operation.

The mine in primary ores at Klappa Kampit—with shafts to a depth of 1000 ft, approximately forty miles of tunnels, and a prewar yearly production capacity of over 2500 long tons of tin—still remained unopened. The whole mine had been flooded before the Japanese arrived. Nevertheless, the invaders had completely dismantled derricks, hoisting equipment, compressor station, work shops, and the 500-ton mill, sending some parts as far as Borneo and Burma. The severe shortage of man power, the great difficulties in obtaining the required equipment, and the tremendous costs involved prohibited the opening of this valuable project.

Production during the first full postwar year was 6000 long tons and in the second year about 8000. The latter included three strike-bound months, so the figure does not give a true picture of the progress made. Production, towards the end of that year, came close to an annual rate of 12,000 long tons which is well over the average prewar output.

Most of the production came from the fourteen bucket dredges. All the dredges have their own concentrating plant, consisting of screen and rougher and cleaner alluvial jigs, on board. The most modern are equipped with a tertiary jig and shaking tables, to produce clean concentrates containing from 72 to 76 per cent tin. The older ones produce a middling product, carrying 15 to 40 per cent tin, which is cleaned in a concentrator on shore. The waste consists mainly of quartz sand and such heavier minerals as ilmenite, pyrite, zirconium, and sometimes monazite. Sulphides of basic metals like lead, zinc, bismuth, and copper occur only in traces, ac-

Counterbalanced monitors stripping overburden in an open-cast mine. Loosened overburden is often made to flow in the empty part of the pit; otherwise, it may be pumped behind the dikes that close off the pit.

counting for the high-quality tin produced from the concentrate without processing. As quartz and clay are the bulk of the gangue, the concentration process on the dredges is simple. Lumps of clay are screened off by a huge rotary screen whose openings range from ½ to ¾ in. in diameter. The underflow contains enough water to flow freely over the primary jigs, which make a low-grade concentrate and clean tailing. Most jigs are duplex with four lengthwise cells measuring 3 ft 6 in. square. Various makes are in use. As the Company has always shown an open eye for progress and better recovery, practically all kinds of jigs have been tried. The postwar dredges are all equipped with Pan American balanced placer jigs, built under license in the Netherlands.

The size of buckets in the dredges varies, depending on the size of the ore reserve in the particular valley the dredge has to work. Eight dredges are equipped with 7-cu ft buckets, one with 5-cu ft buckets, and the remaining five, including the two postwar dredges, with standard 14-cu ft buckets. The digging depth varies according to the depth of the valley; nearly all 14-cu ft dredges have a digging depth of 100 ft under water level.

The dredges are now working 24 hours a day. Stoppages, including voluntary ones for changing buckets, cleaning, and other repairs, usually amount to less than ten per cent of the total time. Output varies with the size of buckets and speed of digging, the larger dredges averaging about 500 cu yd per hr or 4,000,000 cu yd per year.

All dredges are electrically driven. Most 7-cu ft dredges are fed from the main power station at Manggar. The two 7-cu ft dredges in Tandjong Pandan district generate the needed electric power on board by wood-fired steam engines. About 700 hp is required for this size.

The larger dredges are, with one exception, equipped with three Diesel generator sets of 600 to 700 hp each, one of which acts as a standby. This setup makes the dredges well suited for sea operations (in some cases the tin-bearing valleys do not stop at the shore line, but extend into the sea). The construction of these particular dredges, all of which have been towed over thousands of miles of ocean, makes operation offshore just as easy as inland. The movement of the dredges is done by winches and cables, the winches being placed in a row and driven by one electric motor.

Tin production of the dredges varies considerably. The all-time high was reached by the Karimata dredge, owned by the Billiton Co., which in one exceptional month in 1941 yielded 750 long tons of tin. However, a production of 500 long tons per year for the smaller dredges is a better approximation of their output.

Following the dredges in importance are the hydraulic mines. There, pumps for water and gravel are mounted on steel pontoons which can be floated from one part of the pit to another. At two of the mines, the pumping plants produce a 70-lb water pressure at depths of approximately 60 to 80 ft. The loosened overburden is often made to flow in the empty part of the pit, or pumped behind the dikes closing the pit. The lower ore-bearing deposits are pumped by a 12-in. gravel pump to sluices, wherein the cassiterite is captured and cleaned to a 20 to 30 per cent concentrate and then transported to a cleaning plant. This process prevents loss of the fine cassiterite. Since the plants have a first cost lower than the dredges, they could, in prewar time, compete with the dredges as far as over-all expenses were concerned. They have the advantage that the bedrock can be inspected at all times, thus preventing the losses which may occur in dredging. Much planning is required and the construction of dikes takes great skill. Extensive knowledge of the overburden is necessary as soft or muddy strata may easily start landslides of enormous proportions, causing great damage to pipe lines and to the station.

The smallest mechanized hydraulic units, which through their large number contribute a large share to the general output, use 6- to 8-in. pressure pumps and 6-in. gravel pumps. Wide valleys are often worked with two or more sets simultaneously, thus decreasing the ratio between total yardage and useful yardage and diminishing the danger of flooding. Electric power is preferred in these mines because of its simplicity. Since war damage decreased the capacity of the main power plant, a large number of Diesel-pump sets were ordered in the United States. These performed well after sufficient experience was obtained with them. Gardner-Denver pressure pumps, directly coupled to General Motors 6-71 Diesel engines, produce about 1500 to 1600 gpm with a pressure of 80 to 100 psi at the nozzle. For exceptionally hard clays, two of those units are sometimes worked in series, increasing the pressure to 160 psi. The gravel pumps widely used before the war were of Billiton's own design, fabricated in the Indies or in the Netherlands. After the war a large number of American pumps were ordered. Those pumps, made by the Ellicott Corp., of Baltimore, are of the 6-in. size and are multiple V-belt driven by Caterpillar D 13000 or General Motors 6-71 Diesel engines. Such units will move from 40 to 80 cu yd per hr—depending largely on the toughness and thickness of the deposit—the tin-bearing deposits being piped to sluices, often arranged in duplex. The depth of those pits ranges from 10 to 50 ft.

Other earth-moving equipment such as bulldozers, draglines, and excavators is used on a small scale, mostly for preparing mine roads, constructing small dikes, digging fresh-water canals, and various other jobs. Prewar trials of small units for excavating overburden and ore deposits were not promising enough to warrant their use in a period of rehabilitation when, with few skilled employes left, too much had to be planned and carried out. No doubt, in a later stage, the use of larger draglines for removing overburden and ore deposits will be tried out.

Singkep, a smaller tin island also mined by the Billiton Co., was even worse hit by the war than Billiton. The central power station, transformer stations, and power lines were completely dismantled and the parts shipped elsewhere. Two dredges suffered a similar fate and from two others all equipment and top structure were removed. The opencast mines had been completely drowned and all the equipment sent to Malaya and the Riouw Islands. On Singkep the Company got the same friendly reception on its return. Once a slight disturbance was experienced when republicans from Sumatra tried to interfere, but the job of reconstruction was not halted. By the end of May, 1948, tin production was at an annual rate of better than 3000 tons. This figure is 25 per cent above that of the best prewar year. Most of the increased output was due to the two new dredges built in the Netherlands after the war.

Reconstruction in the Banka tin mines was greatly handicapped by the late return of the Dutch—about five months after the reoccupation of Singkep and Billiton. (Banka tin mines were owned and operated by the Government of N.E.I. until last year, when the Billiton Co. was awarded a management contract.)

Fortunately, through the foresight of the late managing director of the Billiton Co., J. van den Broek, who directly after the war ordered two 14-cu ft bucket dredges ("Roosevelt" and "Stuyvesant") from the United States, and six dredges of the same size from the Netherlands, it was possible to tow four of those potential producers to Banka during 1947. As these dredges are equipped with their own power stations and were nearly complete when leaving the shipyard—the only things that remained to be finished upon arrival were roofing, siding, and attachment of the bucket chain—they began production a few months after their arrival.

Aided by a large Chinese population, numerous steam engines, and electric motors, a great number of hydraulic mines were in operation by May, 1947. By that time four dredges, of a prewar total of eight, had started. Of the suction cutters, one out of three was in operation. The total production during the first five months of 1947 was a little over 3500 long tons, an annual rate of 8400 long tons, less than half of the average of the four prewar years.

The combination of the three major tin islands under the skilled management of the Billiton Co. will soon prove well justified through its output of this much-needed metal.

Research Committee on Comminution Organized

The organization meeting of the Research Committee on Comminution, formed by the AIME Committee on Research, was held Nov. 23, 1948, at Battelle Memorial Institute, Columbus, Ohio. The purpose of the meeting was to outline research that should be undertaken to advance the art and science of crushing and pulverization of coal, ores, and industrial minerals. Primary consideration was given to a plan for collecting operating data on existing mills in industry, including performance factors of the mills and technical data on the strength of the input materials and on the fineness of the product. A subcommittee will be named to undertake the work.

No adequate theory or explanation of the physics of comminution is known. Rittinger's law and Kick's law are believed to be incomplete. Fundamental research will be needed to find the relation of energy consumed in the process versus the new surface produced. A group is being formulated under the committee for this study. Laboratory tests have not been standardized to measure the crushing properties of the raw materials nor to measure the fineness and surface of the product. The graphing of the data is not well understood. New tests are undoubtedly needed to measure the resistence to crushing, even in relative terms. A committee on laboratory technique will be organized.

The final membership of the main committee is to be named by Fred C. Bond, chairman. The next meeting of the committee will be at the San Francisco Annual Meeting, at which time the forms for collecting operating data will be reviewed. The work of the committee is of interest to three Divisions of the Institute: Minerals Beneficiation Division, Industrial Minerals Division, and Coal Division. Members interested in the work are urged to get in touch with Mr. Bond at the earliest opportunity.

At the organization meeting of the Research Committee are: (front row l. to r.) O. F. Tangel; A. C. Richardson; F. C. Bond, chairman; E. R. Kaiser, chairman, AIME Committee on Research; R. M. Hardgrove; (second row) C. F. Clausen; H. R. Spedden; L. A. Rhodes; D. W. Scott; Tom Fraser; H. M. Zoerb; W. O. Hinkley; (third row) C. F. Thompson; T. M. Morris; C. H. Bowen; W. A. Mueller; D. Weston; R. A. Sherman; L. I. Cothern; and W. K. Bock.

Polish Coal Mining Rejuvenated

difficulties overcome, the area will supply Europe's needs

Polish coal miners of the Concordia colliery of Zabrze (Hindenburg), Silesia. Miners' wages amounted to 57.8 per cent of production costs in 1947.

After an adventurous past—four changes of government in thirty years—the whole of Silesia and attached coal territories have become part of the Polish State. The coal resources of this area are the biggest among the European countries. Under a surface area of 5700 sq km are about 100 coal seams, with a total thickness of 150 meters. According to German estimates, there are some 150 billion metric tons of coal ranging in thickness up to 14 m within a depth of 1500 m. The seams are mostly level, free from faults, with good top and bottom; the coal is of excellent quality, hard and clean; and mining conditions are favorable. The mines are worked at considerable depth by means of vertical shafts and operate with cage and skip hoisting. Before the war, the mines were up to date, equipped with modern machines. Among the European countries, output per man shift was the highest—1.9 to 2.1 metric tons— and cost of production was the lowest.

seventh largest producer

Poland stands in seventh place among the coal producing countries of the world. Within the present boundaries, the output in 1947 was 59,130,335 metric tons.

After the liberation of Poland and the so-called "regained territories," former German territories as far as the Oder River and Stettin, the collieries were in a critical situation for retreating German troops had dismantled and damaged the surface equipment. Other industries stood still too. The first steps taken toward reconstruction and recovery had to be in the coal mines in order to provide fuel for the closed Polish industries. The Germans had despoiled the coal mines so badly that in 1945 they could produce only 20,168,642 tons (all tonnages in this article are metric). During the war the average depth of the existing mines increased by 300 ft, twice as much as if economic mining methods had been used. The machines and equipment were worn out completely and coal reserves were exhausted; further, miners' homes were broken down and the food situation was desperate. But the Poles overcame these difficulties.

mines run by State

Much had to be done to develop the mines so that they would produce as was planned in September 1946. Reconstruction of the coal industry would cost, according to the three-year-plan estimates, $220,000,000—75 cents for each ton of coal to be mined during the next three years.

After the liberation, the State took over all the mines, without exception. Output, following a short period of uncertainty, soared sharply, mainly in the former Polish territories. In May 1945 the monthly output figure was only 919,425 tons; by November 1945 it had risen to 3,114,308 tons. The output that year totaled over 20 million tons. In 1946 the annual output was 47,288,004 tons, and in 1947 59,130,335 tons. Comparing recent output figures to those of 1938, coal production of the former Polish territories was 38.1 million tons in 1938, and 39.7 million tons in 1947; output of the regained territories was 31.2 million tons in 1938 compared to 19.1 million tons in 1947. The remarkable feature is the production rise in Poland and the sharp drop in the regained territories. The latter was due to the fact that a great number of German engineers, technicians, and miners had fled to the western zone of Germany before these territories were occupied by the Russian troops. In addition, the technical staff and forced labor, which had been utilized by the Germans, evacuated with the German military commanders, leaving the mines undermanned. This condition still persists. In 1945 and in the first part of 1946, when production was on a low level, the lack of men, equipment, and development caused no great difficulties; but in the second half of 1946 and mainly in 1947, the demand for ever-increasing production created headaches for the leaders of the industry. To overcome these difficulties, considerable effort was expended to increase the number of miners, restore discipline, and supply the most urgently needed equipment. German administration of the last two war years did not care about development and did not replace worn-out machines. Moreover, the number of war-damaged surface plants was considerable and the retreating German forces dismantled and destroyed several mines. Money and materials were needed. Investments from home sources amounted to 3,757,000,000 zloty in 1946, and to 70,184,000,000 zloty in 1947. Mining machines imported from abroad, mostly from Britain and the United States, totaled $4,324,000 worth, in 1947. Mining machines and equipment are being built in eleven large factories that work for the coal-mining industry.

development on large scale

Large-scale development plans have been made for supplying worked-out areas. The length of haulageways and headings was increased by 14 per cent by the end of 1947. Shaft sinking amounted to 1276 m in the past year. However, the great efforts made for reconstruction of the coal industry were not enough to meet ever-growing demands for fuel. Further investments were required in 1948 and will be in 1949 to fulfill the output target fixed by the three-year plan.

Man power is the foremost problem of the Polish coal industry. It is believed that the simplest and cheapest way, under present circumstances, to increase production is to put more and more men to work in the mines. The number of mine workers is over the prewar level by 45 per cent yet the output is lower than in 1937 as can be seen by the low output per manshift compared to the prewar values in Table 1.

Table I—Output per man-shift of the Polish coal industry within the present boundaries, in metric tons

	underground	*over-all*
1937	2.413	1.738
1948, April	1.831	1.314
1948, May	1.740	1.209
1948, June	1.828	1.349

Although unavoidable difficulties created by the war—worn-out equipment, depletion, etc.—are partly responsible for low output, yet the main reason for producing so little is the bad organization, decreased discipline of mine workers and, in addition, the lack of co-operation between high administration and technicians. The relations between technicians and mine workers are not good either.

miners return

After the war, it was possible to increase the number of miners by repatriating those who had been carried off by the Nazis to the Reich and forced to work in German mines. In 1946, 5518 miners and their families returned and settled in the regained territories; prewar voluntary emigrés to France and Belgium repatriated in 1947 amounted to 3090; 5000 more were expected in 1948. New recruitments from inland accounted for 8852 men in 1947. These men are highly skilled and their return added much to the increasing production capacity of the Polish coal mines. The housing problem is a major one and great effort was made to repair damaged houses in the vicinity of the coal mines and to build new houses for the miners returned and recruited. The shortage of building materials is hampering the program of house building and the shortage of flats is a constant complaint of the miners. The number of mine workers on June 30, 1948, was about 200,000, increasing to 203,000 by July 31. According to the three-year plan this figure should be increased to 250,000 by the end of 1949.

The earnings of the miner are higher than other workers' wages. Miners received a great number of preferences—greater rations of food and clothing at considerably lower costs. Due to high wages and low production, the cost of production is high, wages amounting to 57.8 per cent of production costs in 1947 according to official report.

coke ovens being restored

Of the 21 coking plants, seventeen are in operation and four war-damaged plants are being repaired. The war-damaged and obsolete plants, 43 batteries with 1722 retorts, most of them worn-out, have at present a daily coal charge of 15,000 tons which amounts to 75 per cent of the prewar capacity. Four batteries of 181 retorts with a capacity charge of 2800 tons per 24 hours are under reconstruction. The speed of reconstruction depends on deliveries of the necessary equipment and special installations for coal by-products, most of which must be imported from abroad. Due to the shortage of pig iron and steel, foundries and machine factories are unable to obtain all the iron and steel they need. That is why deliveries from home factories are delayed. In addition, shortage of foreign currencies hampers shipments from abroad.

Eight per cent of the total coal pro-

duction is being absorbed by the coking plants, which is half of the coal production suitable for coking. It is intended to increase the coke production to 15 per cent of the total coal production so that the entire production suitable for coking can be absorbed by the coking plants. It is doubtful whether this goal will be reached if coal production increases as expected. Coke production within the present boundaries, in 1938, was as much as 644,000 tons. In 1945 production dropped to 338,546 tons, then sharply soared in 1946 to 729,438 tons, in 1947 to 949,903 tons. This was a great achievement considering the immense obstacles to be overcome.

Management of the coke plants, which are owned without exception by the State, is divided between three State authorities: Coal Board, Iron and Steel Board, and Chemical Board. To co-ordinate plants and production, a Central Development Committee was established. Each of the above-mentioned boards has delegated two members to that Committee, and the Electricity Board has delegated two members, bringing the total to eight members; they are presided over by one member delegated by the Coal Board. They have drawn a ten-year production plan in order to develop production and to modernize the industry.

Polish coal exported

Coal is by far the biggest Polish export. It plays such an important part in the national economics of this country because it makes possible the importation of valuable equipment necessary for domestic industries. Coal is the Polish hard currency accepted by the European countries who need it badly. Coal shipments to various countries amounted to 13,553,000 tons in 1946, and 19,400,000 tons in 1947. In the past year, 44.2 per cent of the total export was shipped to Russia, 2.6 per cent to the Balkan countries, 12.5 per cent to central Europe, 25.2 per cent to Scandinavia, and 12.8 per cent to western and southern Europe. Shipments to the European Coal Organization members amounted to 4,227,000 tons in 1946 and 8,150,000 tons in 1947. Total exports in 1948 were to amount to 24,500,000 tons with 14,150,000 tons going to the ECO. Polish coal is indispensable to European economic life as well as to Polish interests. That is why Poland exports coal with pleasure, as much as she can, without regard to ideological differences existing between her and most of her customers.

The European coal deficit will cease in 1951 according to European Coal Organization estimates. It is believed in Geneva, residence of the ECO, that the coal situation is on the way to recovery. The estimates on future production and consumption are in Table 2.

In 1951, England, Germany, and Poland will completely supply the European coal need. It is planned to increase British coal exports to 30 million tons per year, German shipments from the Ruhr to 34 million tons annually, and Polish exports to 41 million tons. Poland should raise her production over 80 million tons annually by 1951. Once reconstruction is complete the mines will be able to produce as much as 100 million tons without further shaft sinking.

Special interest was taken in reconstruction of the destroyed coal-handling facilities at the ports of Szczeczin, Stettin, and Gdansk (Danzig). The ports, especially Szczeczin, were badly ravaged by the Nazis. Ninety per cent of the equipment and docks of Szczeczin were destroyed. Most of them have been restored and now coal can flow uninterrupted to the coal-needy countries.

shortage of engineers

Under the present circumstances there is a shortage of engineers, technicians, and skilled labor and with growing production the difficulties caused by this situation will increase. A vast educational scheme to overcome these difficulties has been established.

Table 2—European coal outlook between 1947 and 1951

	Million metric tons				
	1947	1948	1949	1950	1951
Requirements .	510	540	550	560	570
Production	440	490	525	550	580
Deficit	70	50	25	10	..
USA shipments	35	40	25	10	..
Deficit	35	10	..	..	..
Surplus	..	..	..	..	10

Loading crane for the destroyed port of Gdansk (Danzig), to increase coal exports.

The Scientific Research Institute under the Coal Board is concentrating on giving vocational guidance to candidates for employment in the mines and for vacancies in the mining schools, and on training mine workers, particularly those with safety duties. The vocational guidance work is still of an experimental nature. It follows the progress of the pupils sent to the mining schools in order to test its own efficiency. In preparation for examinations for miners, the Institute is drafting monographs on the mining occupation and is also preparing apparatus and procedures for testing miners; this is being done in co-operation with similar authorities in other countries. The Institute intends in the future: (1) to continue the vocational selection and guidance of adolescents, (2) to continue its analysis on mining occupations, (3) to organize lectures on industrial psychology for supervisory mine personnel, (4) to study the causes of industrial accidents and means for their prevention, and (5) to prepare principles for psychomedical diagnosis.

The Government intends to train mine workers and give them speedy courses so that they can replace engineers who were educated in the past and whose idealogical attitudes do not correspond to the present requirements. Several afternoon engineering courses are provided for men who have passed only elementary examinations.

The Mining Academy of Kraków is one of the biggest and most important institutions for mining engineer-

ing in eastern Europe. The number of chairs filled is 61 and over 300 fellows, research assistants, and other scientific persons are at the Academy. The number of students is over 3000. Under the present rector, Mr. Goetel, there is much educational and scientific activity at the Academy directed toward solving the special scientific problems of the Polish mining and metallurgical industries.

outlook bright

Coal production for 1948 was set at 67,500,000 tons. In the first half of 1948, it was 33,400,000 tons, slightly under the target, but the desired production probably was reached. Production of coke in the first six months of 1948 was 2,264,000 tons, 109 per cent of the production goal. The number of plants under operation is 77, and it is not intended to increase the number of plants in order to increase production.

Having a production capacity of 100 million tons, it is believed that the present 77 mines can produce 80 million tons annually after being restored to normal operation. This should be achieved by 1951. Coke production will be increased from the present level of 4.5 million tons annually to 10 million tons. This latter is an optimistic view and does not take into account the difficulties of installing new batteries. The coal target is realistic, however, and it can be taken for granted that Poland will supply Europe with up to 40 million tons of coal until 1951 as planned by the United Nations Economic Committee. Preliminary talks have been held between Czechoslovakia and Poland for establishing a joint coal and steel production plan on grounds of the unified administration of their large industrial areas between Katowice and Ostrawa. This area includes the whole territory of Upper and Lower Silesia and the adjacent coal basin in Czech territory. This area of a vast coal and steel industry is to be under common Czech-Polish administration and will be regarded as a "second Ruhr" on which will be based the industries of the eastern European area. The present production level of this territory is about 80 million tons of coal, 2.5 million tons of pig iron, and 4.0 million tons of steel annually. The Governments concerned intend to increase production to 110 million tons of coal annually, 8 million tons of pig iron, and 12 million tons of steel within twelve years. The economic co-operation between Czechoslovakia and Poland is developing rapidly and these territories will be, next to Russia, the largest economic unit in eastern Europe.

Letters to the Editor

India Not Responsible

Charles Pettinos adds further information on French graphite mentioned by Mr. Wright in September M&M:

I have read with much interest the article "French Mineral Position," by Charles Will Wright, and especially in connection with graphite. His report on Madagascar flake graphite is pretty close as to tonnages, but low market prices did not result from competition from producers in India, as these two productions are used for entirely different purposes. The Madagascar flake graphite is used all over the world almost exclusively for the manufacture of crucibles, and little for any other purposes. The reason for the low production in 1947 was not because of competition, but for the reason that in April of that year a general native rebellion broke out all over the island.

There are four or five large producers (all French) and about the same number of smaller ones. Their mines are scattered over the central and eastern part of the island, in sparsely settled or uninhabited areas, with means of transportation to the seaboard or railroad, very difficult. The native rebels destroyed all but one or two of the plants at these operations, and the white managers were evacuated to Tananarive, the capital.

Most of the graphite obtained through 1947, and up to a few months ago, consisted of what could be recovered from the wrecks of these plants, material already finished and apparently of no interest to the rebels. Operators, under military escort, went out to these various places, scraped the material together, rebagged it, got it to the port of Tamatave, and shipped it out. Our own representative in Madagascar obtained a good many hundred tons in this manner. Naturally, prices advanced rapidly as the material was badly needed both here and abroad. The French government makes these prices, f. o. b. Tamatave, and they have already been advanced three times in about the last year.

Mr. Wright is correct in stating that our government is planning, through the Marshall Plan, to provide money to help rebuild these destroyed plants, and already several of them have resumed operations, but not yet in a normal way. There is no amorphous graphite in Madagascar, as far as I know. At any rate, I have never seen any.

Rich Mica Deposit Undeveloped

Having seen our story on an Australian mica discovery in September M&M, George L. Holmes recalls one that he knows about and writes:

Since commercial mica is not too frequently found, the discovery of a mica deposit in a remote and almost inaccessible region of Australia is of interest to the world and to mining engineers in particular.

On the inner side of the Big Bend of the Columbia River, in Canadian territory, right opposite the mouth of the Canoe River which enters the Big Bend from the north, there is a trail leading to the top of the mountain and also to what is probably the finest deposit of mica on this continent. The summit is on a dike of pegmatite in which book mica of large size is found. This deposit, although known to a few people, is not to my knowledge being worked and it may be open to location.

The late J. M. Davidson, father of Fairbanks Exploration, called my attention to it first. Later, Davidson had

(*Continued on p. 42, Sect. 1*)

Nome, Alaska, September, 1908. Grouped left to right are: Tom Gibson, mining engineer; Scott Turner; T. A. Rickard, editor, *Mining and Scientific Press;* C. H. Munroe, Wild Goose Mining and Trading Co.; and Jafet Lindeberg, Pioneer Mining Co.

Scott Turner—An Interview

By JOHN V. BEALL • MANAGING EDITOR

Let's start at the beginning, Mr. Turner. Where and when were you born?

In Lansing, Mich., on July 31, 1880.

And what was your education?

I went to the University of Michigan, where I got an A.B. degree in 1902; then to the Michigan College of Mines at Houghton, graduating from there in 1904 with a B.S. and an E.M.

What was your first job in the mining industry, Mr. Turner, and what were you paid?

In the summer of 1902, I was a field assistant for the U. S. Geological Survey in southwestern Idaho and southeastern Oregon, working under Israel C. Russell, professor of geology at the University of Michigan, who incidentally, had just returned from an expedition to study the effects of the eruption of Mt. Pelée, on Martinique. I was paid $60 a month and found; in addition to doing geologic and hydrographic work, I cooked many of the meals for a party of four, and wrangled four horses. I slept for four months under the stars, without a tent.

After graduating from the mining school, I went to Tombstone, Ariz., for the Development Co. of America which had consolidated the old mines in that area and was reopening them. At first I was a miner, later a surveyor, and then I helped build and operate a small concentrating and cyaniding mill; I also did sampling and examination work. I gave that up in 1905.

Then what happened?

At that time I joined forces with another engineer, and together we became tramp miners and millmen. We visited various camps in South Dakota, Montana, Washington, Oregon, California, and Nevada, looking for knowledge and experience.

Tell me about some of the places where you worked.

In California, I worked in gold mines on the Mother Lode, near Jackson and Amador City. In Nevada, we were mostly around Virginia City, in the mines and at the only mill there, operated by Jim Kincaid, an old-timer. He milled screenings from the old dumps. Across the valley, Charles Butters was trying to cyanide large tailing piles, but his operation ultimately proved unsuccessful and was abandoned. Later, in Colorado, I was surface foreman at the new Rowe mill, at the portal of the Yak tunnel in Leadville. Afterward, I went to Gunnison County and became millman at a gold property near Tin Cup. I also investigated some placer properties. Not long after that, a telegram came offering me a job as an examining engineer for two Midwest companies operating in the Republic of Panama, so I left Colorado hurriedly to sail from New York to the Canal Zone, whence I went

Biggest black bear shot in the United States or Canada in 1938 was the feat for which Mr. Turner was awarded the first prize in a national championship competition.

by coastal steamer to Aguadulce, and by mule to Santiago, Cañazas, and to the camp at Veraguas Peak.

That must have been toward the end of 1905. What was going on in the Canal Zone at that time, and what did you find at the mines?

The U. S. Government was starting sanitary work; yellow fever and malaria were endemic. Progress on the Canal was deferred until health conditions could be improved. However, I only stayed long enough in the Canal Zone to get supplies to take to the mines in Veraguas, 200 miles from Panama City.

After prospecting, sampling, and assaying, the chances for the success of the ventures did not appear good, and so I reported by cable to my principals in the States. As they had spent considerable money on their ventures, they asked me to remain there in charge of the work, to see whether pay ore could be developed. I did stay, but I did not find any reason to change my original opinion.

So you left Panama, and went to other mining areas?

Yes. When I got back to the United States, a syndicate sent me to the boom camps of Nevada. From Tonopah, I traveled to all the new camps. I was in Goldfield when the first important strike was made on the Mohawk, which later became part of Goldfield Consolidated. I examined and sampled prospects over a wide area, and went through some interesting boom times in new camps, some of which sprang up overnight.

Where did you go from there?

I headed north to the Coeur d'Alene; it was toward the end of a hot summer, and I felt I would appreciate the green coolness of the mountains in northern Idaho. I worked at the Standard and Mammoth, then at the Hecla mill, and ended up as millman at the Hercules mine, then just coming into profitable production.

How did you happen to leave Idaho, and where did you go?

Like other young fellows who want to get ahead, I was not satisfied to stay in any subordinate position longer than was required to learn what the job would teach. So about that time I decided to get out letters of enquiry. To do this properly, I needed a typewriter. I ordered a secondhand one sent from Chicago, and the night the typewriter arrived, I saw an advertisement in the *Mining and Scientific Press* for an assistant editor to work under T. A. Rickard, and I immediately typed and mailed my application. That neatly typewritten letter (I later learned that most of the applicants had written longhand), and the fact that Mr. Rickard remembered me from Houghton days, when I had first known him while he was collecting material for his book on the copper mines of Lake Superior, landed me the job. I owe a great deal to Mr. Rickard.

How long did you continue in that position?

About ten months; I was too young and full of energy to stay long at a desk job. Mr. Rickard understood my desire for active field work. In November, I took a job as superintendent of a small gold mine in Nevada, and stayed there until I got a better chance.

What did that chance turn out to be?

Fred W. Bradley offered me a job as field engineer, and soon sent me to straighten out metallurgical settlements at the Tacoma smelter. He was shipping under contract all crude ore and concentrates from the Bunker Hill and Sullivan, and all gold-bearing pyrite concentrates from the Alaska Treadwell group. Mr. Bradley was president of all these companies.

Shortly after, Mr. Rickard stepped into the picture again. He wanted to make an inspection trip to Alaska and the Yukon Territory, and arranged with Bradley to borrow me to accompany him.

Tell me about that trip.

We first investigated small copper properties near Skagway, and then went down the Yukon to Dawson, where the Yukon Gold Co. was starting large-scale dredging and placer mining. We thoroughly inspected that work, then went up the Tanana River to Fairbanks and looked over the alluvial operations in the adjacent area; later we moved down to Hot Springs where some interesting placer work was being done. We then went down the Yukon to St. Michael and across to Nome, and spent some time examining the operations of the principal companies in that and adjacent areas.

How did you happen to leave Mr. Bradley?

I was offered the post of assistant geologist by the U. S. Smelting Mining and Refining Co., first reporting for work at the Mammoth copper mine in Shasta County, Calif. I feel certain that Rickard again played a part in my getting that job. I held the assistant geologist job

about a year, at the end of which time—that was 1909—the contract of the chief geologist expired and I was advanced to his position. I took over the work in the beginning of 1910 and remained with the Company another year, doing geology and making mine examinations.

When you finished this work what did you do next?

It was suggested that I investigate some properties in North Africa, and so I proceeded to Tangier—that was in 1911—only to find farther progress blocked because of the unsettled international situation in French Morocco. Warships of several nations lay in the harbor and trouble threatened. I could not get from the French commander the necessary permit to proceed through Fez to the properties I was to examine, so all I could do was to investigate iron-ore deposits near the Moroccan coast.

What did you do after that?

I spent several months in Spain, and eventually went to London, where I again encountered Mr. Rickard, who was publishing and editing the *Mining Magazine*, his third major editorial job.

What did you do in England?

I spent some time in Cornwall going through the Dolcoath, Whealkitty, East Poole and Agar, and other tin mines.

In London, were you looking for steady employment in European mines?

In a way. I was meeting many prominent engineers, and I found that various jobs were open. It so happened that one Friday I had three mining offers in my pocket, with final decision required by Monday. It was a tough choice to make, especially as each involved moving to a distant country, and it was apparent that the course of my future professional life would be profoundly influenced by the decision I had to make at that moment.

What were the jobs?

One was manager of a copper property in Catamarca, Argentine Republic; another was to make examinations of gold placer deposits, and of various metal mines, in eastern Russia, for a French company. (My tickets over the trans-Siberian railroad to Vladivostock had been purchased.) The third job was to examine iron-ore deposits in northern Norway and Sweden, and coal deposits in Spitsbergen.

Which did you choose?

Right or wrong, I chose coal and iron, and proceeded at once to the north of Norway, from which point I visited various iron mines in Norway and Sweden then under option to my employers. Then I went by employer-owned ship to Spitsbergen, an archipelago lying several hundred miles north of Norway. After completing my examinations, I returned to America, where I finished reports and recommendations for my principals in Boston. Then I started for the West, to resume the practice of my profession in my own country.

Did you do so?

No. J. M. Longyear, a prominent mineowner of Marquette and Boston, and a half owner in the Spitsbergen and allied ventures, telegraphed me to meet him in Duluth for an inspection trip through the Mesabi iron-ore areas, and, after a fortnight spent together, he asked me to become European manager for himself and Frederick Ayer, also of Boston.

I sailed for Norway at the end of 1911, and went to Tromsö which was our engineering, sales, and shipping headquarters. My multiple position was general manager for Arctic Coal Co., European manager for Ayer and Longyear, and manager of the Arctic Steamship Co. and other companies controlled by the same people. Our base at Spitsbergen was Longyear City, in Advent Bay off Ice Fjord, on the west coast of the island of West Spitsbergen. We built the town at 79° 13′ north latitude, about 875 miles north of the northern tip of Iceland and only 720 miles from the North Pole. The archipelago was completely uninhabited before these American operations started; we were about 1000 miles farther north than Nome, and it was too far north even for the Eskimos. We completed an electric power station, loading docks, industrial railways, wire-rope tramways, and a townsite, with offices, warehouses, and residences.

To whom did the island belong?

Nobody. At that time, it was No Man's Land—*terra nullius*. No nation claimed sovereignty, no one governed it, and no courts had jurisdiction over crimes committed there. We flew the American flag over four tracts, each of an area of 150 square miles; the only laws were those written into our employment contracts (which we had to revise from time to time in order to plug loopholes which we had not foreseen). For the five years I was there, I administered these contract laws, and provided such authority and government as there were.

Tell me about the mining operations, Mr. Turner.

I had topographers, loaned by the USGS, map an area of about 100 square miles. We established base lines, triangulated the area, and mapped contours at 10-ft intervals. Using this base map, we prospected the tract, and eventually established mine entries in coal outcrops at 52 widely-scattered points. Slopes were driven in the coal at various points on the outcrops; some reached lengths of more than 2000 ft before I left the island. We divided the best coal seam into separate panels, and mined them by different methods, to get comparative costs. We tried the longwall-advancing method, using English disc coal cutters; the longwall-retreating method; and the room-and-pillar method which is common in American mines, both hand undercut, and using modern coal-cutting devices. One panel was equipped with mechanical face conveyors, electrically operated, which was advanced practice for those days. Several variations of these methods were used in other panels.

I had English supervision in the panels using English methods, and American where we used American methods. Three quarters of the miners were Norwegians and the rest Swedes and Russians, all brought to the island in company-owned ships. Room-and-pillar mining, using short-wall chain cutters, proved the cheapest over a period of time.

The coal outcropped high above the valley floors, and all entries were made in the outcrops, so no shafts were necessary. The maximum slope of entry was three per cent. Since the ground was always frozen, there was no water to contend with, although some fossil ice occurred

in thin seams in the coal. Under these conditions there was no chance for gas to form. We had to contend with the usual coal-dust danger, so we used only permissible explosives.

The European war started in August, 1914. How did it affect operations?

Operations became increasingly difficult. Almost all nations from which we drew supplies and men placed export restrictions on goods and made many of our employes subject to military call. Explosives were particularly difficult to get. Ships were scarce and their operation was hazardous. However, we continued to operate and ship coal the first two war years, during which time the Czar of Russia became anxious to purchase our mines to supply coal for his Murmansk railway, which was operated with wood-fired locomotives. The Norwegians also wanted to acquire the mines, because no coal is produced in Norway, and their entire merchant marine, then the third largest in the world, was dependent on foreign coal for bunker fuel. Incidentally, my good friend Hjalmar Lundbohm, general manager of the important Kiruna iron mines in Swedish Lapland, was particularly partial to our Spitsbergen coal. I went to considerable trouble and risk to keep his power plants supplied for the first two war years, delivering the coal to Narvik, in Norway, whence it went by rail to Kiruna.

What happened to the Russian move to acquire those coal mines?

The Russians acquired an option to purchase our properties, for which they paid a considerable sum; the deal was to have been closed in St. Petersburg, now Petrograd, the first of July, 1915. After a conference with my principals in Boston, I sailed from New York, apparently in plenty of time to get there, but an unforeseen accident delayed me for some weeks.

What was the accident which caused the delay?

I was unfortunate enough to board the "Lusitania"; it was torpedoed off the Irish coast on May 7, 1915, and I sustained injuries that kept me in London hospitals for more than a month. Water travel across the Gulf of Bothnia was closed by that time, so I went by rail over the Tornea-Haparanda route, with many delays for Russian inspection. I arrived in St. Petersburg three days late. However, this made no practical difference because, late in June, the Czar found St. Petersburg unsafe and left to join his troops on the eastern front, where the Grand Duke Michael was in command, so that by July 1 there was no one in St. Petersburg with money or authority sufficient to close a deal of this magnitude.

What did you do when you found that none of the high officials were to be found in St. Petersburg?

I retraced my steps to Christiania, which is now Oslo, to confer with the Prime Minister of Norway and members of his cabinet. I was invited to attend a meeting of Norwegian officials, bankers, and industrialists, and there started negotiations which ultimately resulted in the Norwegians' purchase of the mines. This deal was practically completed by April 1, 1916, and the American interests were taken over by the Norwegians.

What did you do then?

I was engaged by a British-Belgian banking house to represent them on the west coast of South America, so I sailed for Callao, Peru, on April 8, 1916. I spent the next two years in Peru, Bolivia, and Chile, inspecting the ventures in which my principals had interests, and examining and collecting data on many mining ventures, the acquisition of which was being considered by them. The work entailed a pretty comprehensive study of the mining situation in those countries at that time. I wrote reports regarding 67 properties in Peru, 45 in Bolivia, and 28 in Chile.

Two Past Presidents of the AIME, Scott Turner and Herbert Hoover, with a Bureau of Mines safety trophy, in 1926.

Next, I joined the U. S. Naval Reserve force, in which I was commissioned a Lieutenant (s.g.), served until the end of the war, and went on inactive reserve duty the end of January 1919. The next day I reported to Toronto, where I became technical head of the Mining Corporation of Canada Ltd. and its subsidiaries, which were controlled by the same financial group for which I had worked in South America.

Tell me about your work with the Mining Corporation.

I was with the Corporation exactly seven years. In addition to operating productive silver mines in the Ontario camps of Cobalt, Casey, and South Lorraine, and other mines in Ontario, Manitoba, and various parts of Canada, the company had mining interests in many parts of the world. We had field parties in China, Russia, Mexico, and Central and South America. We were developing a gold mine in Yenesei Valley in eastern Russia, and held various properties under option. So it was a busy time. The largest new mine owned by the Mining Corp. during that time was the Flin Flon, now operated by the Hudson Bay Mining and Smelting Corp. The Mining Corp. undertook to explore it jointly with others in 1920, and took it over completely in 1921; the work was under my direction until I negotiated its option and ultimate sale to New York interests at the end of 1925. Although the Flin Flon was the biggest mine we developed, some of the smaller new properties, such as the silver group in South Lorraine, Ontario, and others in Manitoba and British Columbia, were equally interesting.

In those days an active Canadian mining company must have considered many properties. During the seven years you were there, how many properties were offered for sale to the Corporation?

I still have a list of the properties proposed to us from 1919 to 1925. They totaled 255 in 1919 and the other years averaged about the same. Over those active years, about one new property per office day had to be considered by a progressive mining company widely known to be looking for new mining ventures.

Why did you leave the Mining Corp.?

Because Mr. Hoover, then Secretary of Commerce, took over the U. S. Bureau of Mines for the Department of the Interior. I was asked to go to Washington and serve as its director, which I was happy to do, although it involved a large financial sacrifice. I had lived for seventeen years in foreign countries, and I welcomed the opportunity to do interesting and useful work in my own country, under congenial leadership. I continued as director for almost nine years; my resignation was accepted early in August 1934.

What was your work on this job?

It would take a long time to answer that question, as the Bureau was active in many fields. The expansion of health and safety work, including first-aid and mine-rescue training, was important; so were the silicosis studies, including the large clinic maintained at Picher, Okla. There were many emergency mine-rescue trips, including the spectacular run of one of our steel cars from Pennsylvania to northern Ontario to deal with a serious mine fire. Also significant was the work in the new technologic branch, in starting studies of geophysics as applied to mineral exploration; acquiring and putting into operation the large helium field near Amarillo, and the design and erection of the new helium-processing plant there; extensive drilling for potash in the Southwest; oil-shale experiments in Colorado; and many metallurgical experiments. These are just a few high lights that occur to me at the moment. Our start of the mining division's studies of mining methods and costs was, for me, at least, one of the Bureau's most interesting activities. Near Pittsburgh, we conducted experiments to determine the best way to ventilate the Holland vehicular tunnel between New York and New Jersey, studies to ascertain the cause and prevention of caisson disease commonly called "the bends," and operated an experimental mine to improve explosives and prevent mine disasters. We made emergency studies in the use of tetraethyl lead, and of ethylene. I enjoyed reorganizing the statistical branch, and beginning the publication of the "Minerals Year Book." Probably these few examples are all you need to illustrate what interesting fields of work occupy the attention of a high-grade technical bureau of this description.

I believe it was while you were in Washington that you served as President of the AIME?

Yes. I took office in February 1932 and served the customary one year, during which time I visited all the Local Sections of the Institute, a job which had not been completed by any of my predecessors.

During recent years, what fields of activity have interested you most?

I have served as officer and director of various mining companies, as consultant to foreign governments, as arbitrator in mining disputes, and as expert witness in litigation; have directed exploration in many countries; have functioned as a general consultant in mining; and have done some mining on my own account. I am still too fascinated by the mining game to quit entirely, although my own personal interests seem to require more and more of my time.

Mr. Turner, you have made a successful career by moving around and changing jobs frequently. Do you think this procedure would be the best way for a mining engineer graduate of today to advance himself?

When you have interviewed a score or more of the older engineers, and have summarized (as I hope you will) the impressions you get from the complete series, I think you will have something to present to the young graduate which will help him decide what he wants to do, and how he can best go about doing it. Even then, each young fellow should remember that luck is a big factor in determining the trend of a man's professional life. Opportunities appear from the most unexpected sources, and must be grasped quickly. Most men find that they have to go where circumstances compel, and not in the direction they have chosen.

Things have changed greatly since I started my professional life. Fifty years ago jobs were scarcer and most young fellows had to take what they could get and be much obliged for the eating money. A certain amount of manual labor in mines, mills, and smelters should be a good thing for any young mining engineer, and many of us, whose finances were limited, had to begin that way in order to live. Nowadays, it seems easier to get a start, and the experience to be gained by work as miner or millman is lacking in the postgraduate education of many a young engineer. If he does not gain this sort of experience soon after leaving school, he is unlikely to get it later. Now he seems to be able to step from the campus directly into technical work. So he will never be a competent miner or millman, and perhaps he is satisfied to have it that way. Anyhow, that is how it is now.

All I can say is that the young graduate should grasp his opportunities as they appear, work earnestly and hard at the job in hand, be as loyal as possible to his superiors, always save part of his pay, and then take advantage of the breaks, to use a current slang expression. As to a long-range plan to go it on your own, it has been said that independence is one of the most expensive luxuries. Maybe, if you can get the chance, it is better to start at the bottom with some big company, and then devote your life to getting advancement within that one organization. It would not appeal to everyone, but many believe it is the best way. That is a matter of individual choice, or chance. Perhaps it is more fun to keep moving while you are young, take some chances, adventure frequently into the unknown, have a variety of experiences, and thus develop a wider professional horizon, even though to do so may be more risky, and may not pay out as well in money in the long run. I do not hold any brief for this method, and if I had to start again, facing conditions as they are today, I might be influenced by all this talk about security, and not want to move about and take the risks we used to enjoy.

Sunnyhill's Colmol advances the entire face in one operation by means of the rotary chipping heads shown at the right.

Coal Mining Faces Transformation

two new machines, developed separately, perform same function— mine and load coal continuously

By JOHN V. BEALL • MANAGING EDITOR

During the last quarter of 1948, two new machines, which may revolutionize the coal mining industry, made their first public appearance within two months of each other. Both are designed to mine and load coal continuously. On Oct. 27, the "Colmol," invented by C. H. Snyder and A. E. Lamm, president and executive vice-president, respectively, of the Sunnyhill Coal Co., was demonstrated at the No. 8 mine of that Company at New Lexington, Ohio. The "Joy Continuous Miner," invented by H. F. Silver, president of the Silver Engineering Works, Denver, and developed and manufactured by the Joy Manufacturing Co., was demonstrated at the Mathies mine, near Finleyville, Pa., in the Pittsburgh coal seam.

Mechanization in underground coal mines has made rapid strides in the past decade, but the development of a machine that could replace the cyclical operations of cutting, drilling, blasting, and loading by one continuous operation has long been the dream of coal operators. In Germany a coal plow has been developed, in Holland a scraper-bucket system, both designed to mine and load continuously. Although these systems may not be adaptable to most American coal beds because of physical property differences, the Europeans have been ahead of us in this line of progress. Early in 1948 a $250,000 program was launched by Bituminous Coal Research to design a continuous coal mining machine. However, with the appearance of the Colmol and the Joy Continuous Miner the outlook is bright for more and cheaper coal. Even though it is claimed that these machines mine more coal with less man power, it is not expected that they will create unemployment since more mines will be opened up. Mining machines of this type should be an important factor in supplying cheap coal for the projected synthetic fuel industry.

how the Colmol works

The Sunnyhill Colmol, which can best be described as a giant mole, advances the entire face in one operation. The machine moves forward under its own tractive power, advancing the face continuously and discharging a stream of coal onto conveyers or shuttle cars for transportation from the mine.

A series of rotary chipping heads, each having widely-spaced and progressively-receding teeth, chip the

Joy Continuous Miners are manufactured in low and high models to work in 40 to 60 in. and 54 to 96 in. coal.

coal in overlapping, annular concentric kerfs, causing coal to be freed from the pressure of the earth and to break out ahead of the teeth. These chipping heads also function as paddle conveyers which sweep the floor of the mine and co-operate with a floor-shearing blade to remove coal from the face and sweep it to a conveyer which loads the coal and carries it to the rear of the machine where the coal is delivered to the transportation system. The widely-spaced, radially-disposed teeth on each of the chipping heads are not only progressively receding from the center of rotation but they are also connected by rearward-sweeping sharpened edges that remove coal from between the teeth if it has not been previously chipped free of the face ahead of the teeth.

Hydraulic cylinders are employed to move the entire cutting head assembly up and down, to tilt it forward and backward, and to vary the distance between the top and bottom rows of the cutting heads. Each of these motions may be controlled separately by means of manually operated control valves which enable the operator to position the cutting head of the machine accurately. Other hydraulic cylinders are provided to raise and lower the tail of the conveyer to suit the position of the shuttle buggy or conveyer. The Colmol is a completely mobile unit, being driven on endless tracks which are designed to turn the machine on a radius materially shorter than its length, thereby reducing the problem of maneuverability in confined passages.

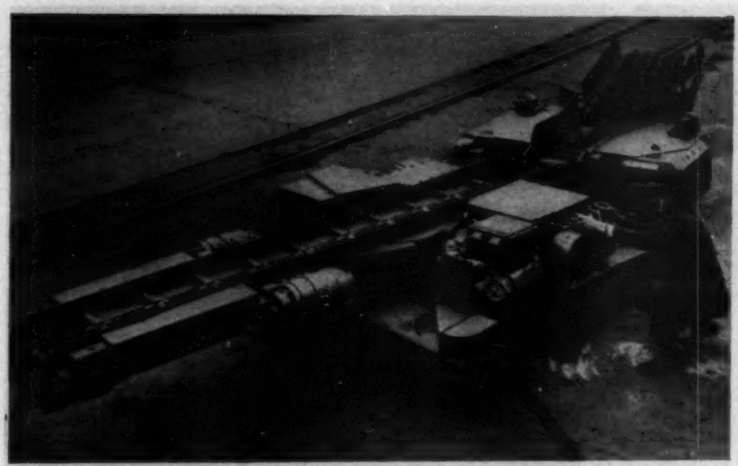
All of the drives are hydraulic, the various pumps being driven by 230-v d-c motors as follows: two of 30 hp for the rotating heads and two of 7½ hp, one each for the conveyer and traction drives. The machine is 8 ft 6 in. wide, 24 ft 9 in. over-all length, 38 in. high, and weighs 26 tons. The size of cut made is 9 ft 6 in. wide, 48 in. high, and an advance of 18 to 36 ipm is claimed. The Colmol is expected to produce 500 to 1000 tons per shift. To accomplish this, it is proposed that one foreman, one machine operator, and two timbermen will make up a machine crew.

Production plans for the manufacture of Colmols are not yet formulated but it is expected that they will soon be made available to all mining companies in several models to cover seams of varying thickness.

operation of Joy Miner

The Joy Continuous Miner consists essentially of a ripper bar or head which tears the coal from the face, discharging it into an intermediate conveyer which loads into a centrally located hopper. From this point the coal is picked up by the rear conveyer which carries it back to the transportation means. Both conveyers and the ripper head are mounted on a main frame which carries the auxiliary equipment and is in turn mounted on caterpillars. The ripper bar and rear conveyer each swing through an arc of 45 degrees from center providing flexibility in operation. The machine is propelled by two caterpillars.

With the ripper bar in retracted position, the machine is advanced on its caterpillars until the ripper bar touches the coal face in the center of the working place. The ripper is then swung to the right and positioned in accordance with the width to be mined. The ripper bar is then lowered to the floor and hydraulically advanced, horizontally, 18 in. into the coal. This advance into the base of the coal seam is known as sumping. At this point hydraulic pressure is applied upward, forcing the ripper bar through the coal to the top of the seam, after which it is retracted and lowered. While the ripper bar is lowered, it is also swung 30 in. to the left about the main turntable and readied for the sumping phase of the next stroke. The strokes are repeated until the desired width of mined area has been reached, at which time the ripper bar is returned to the center of the place and the machine is advanced 18 in. straight forward on its



Two tons per minute is the design capacity of the miner which utilizes a ripper bar to tear coal from the face and two conveyors to deliver it to the transportation means.

caterpillars. The cycle of strokes is then repeated.

The major operating units are electrically driven. Direct 7½-hp motor drives are applied to each caterpillar and to the 15-gpm hydraulic pump. Two 5-hp motors drive the rear conveyer and two 65-hp motors drive the chains on the ripper bar. A drive is taken from one of the ripper-bar motors to power the intermediate conveyer. Power from the hydraulic system is used to position the ripper bar and move it through the various portions of its cycle. Hydraulic power is also provided to lift the cleanup shovel, to lift the rear conveyer, and to elevate the timbering jacks.

The ripper bar is 30 in. wide. It may be lowered to operate 5½ in. below a level mine floor and raised 66 in. (100 in. for the high model) above a level floor. It is equipped with six chains, each containing twenty replaceable bits. Each chain is driven by a separate sprocket on a main driving shaft which is attached at each end to a gear reducer that advances with the ripper head. The ripper bar is carried on a large turntable and advances in rugged slides incorporated in the turntable casting. Two hydraulic jacks are used to swing the turntable; two are used to advance the ripper bar; and two are used to elevate the bar.

All main power circuits are controlled by magnetic contactors. The control circuits are actuated by sealed mercury timing tubes which are operated by the magnetic flux of the main contactors. Main electrical controls are conveniently grouped alongside the hydraulic controls.

Two double-acting hydraulic roof jacks are located ahead of the operator. They may be used either directly to support the roof or to hold a crossbar timber against the roof while posts or jacks are set up under the timber ends.

The over-all height is 34 in. for the low-model and 48 in. for the high-model machine. The length of the machine is 25 ft 6 in. and its width 7 ft 6 in. It can drive a place with width ranging from 10 to 17 ft. The low model operates well in seams from 40 to 60 in. thick, whereas the high model operates in 54 to 96-in. seams.

The Joy Continuous Miner is designed to mine two tons of coal per minute. However, the actual speed with which coal can be mined varies with the characteristics of each seam and of every mine in that seam. It also varies with the efficiency of the transportation system in hauling the coal away. It is said that the Miner has already proved successful in the Colorado Laramie lignite seam, the Pittsburgh seam, the Freeport seams, and the Illinois No. 6 seam. In the Colorado lignite seam, the Continuous Miner is said to have virtually eliminated the need for timbering. It is now being manufactured on a regular production basis at one of the Joy plants in Franklin, Pa.

Improved safety and reduced mining cost are expected from both of these machines. The elimination of blasting is itself a great contribution to safety, since the roof is undisturbed by the constant shocks of powder explosions typical of conventional mining. Further blasting often produces hairline fractures in the coal seam as far as 50 ft from the blast zone and starts subsidence of the overburden with the attendant dangers from falls of rock overlying the coal seam as mining proceeds. Owing to the fact that mining is accomplished in one operation there is a reduction in the time and area exposed, thus making it possible to do less timbering and permitting better supervision and ventilation. Undoubtedly many innovations in mining systems will result and recovery should be more complete and easier.

MBD Business Meeting

By order of the Executive Committee, a business meeting of the Minerals Beneficiation Division is called for Sunday, Feb. 13, at 2 p.m. It will take place in the Empire Room of the Fairmont Hotel, San Francisco. All affiliates of the Division are invited to attend.

New Low-Temperature Carbonization Pilot Plant

A continuous coal-gasification pilot plant, the first of its kind, is currently transforming mediocre coal and char into high-quality gas and tar, at Library, Pa. The metamorphosis is accomplished through an economically competitive process of low-temperature carbonization that extracts large amounts of volatile materials from the coal, before it is burned for its heat values in the usual way. Ordinarily, those volatile fractions of the coal are burned to worthless ash or vapor. The synthetic gas produced at the pilot plant can be used as is or be enriched to make high-grade fuels; and the tar drawn off can be processed further to make liquid fuels and basic chemicals. The pilot plant itself is a product of co-operation between the Pittsburgh Consolidation Coal Co. and the Standard Oil Development Co.

Mineral Economics Division Established—Board Sets Preliminary Budget for 1949

At its meeting on Dec. 15, President Wrather presiding, the AIME Board of Directors recognized the newly organized Mineral Economics Division, established the preliminary budget for 1949 in new form, and decided to discontinue the Junior Foreign Affiliate grade of membership at the end of 1949 provided the necessary change in the bylaws is effected.

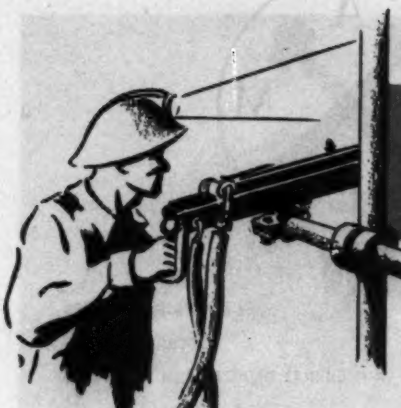
Richard J. Lund presented the petition for the establishment of the Mineral Economics Division. The President of the AIME is to appoint the initial officers, consisting of a Chairman, three Vice-Chairmen, and a Secretary-Treasurer. Ten committees are specified in the bylaws, as follows: National Security, Conservation, Tariffs and Subsidies, Taxation and Finance, Foreign Mineral Policy, Statistics, Transportation, Marketing, Mineral Use and Substitution, and Management and Public Relations. The purpose of the Division "shall be to stimulate interest and promote progress in broad economic and political aspects concerned with the search for, finding, developing, producing, transporting, refining, marketing, and use of metals and minerals of all kinds, including mineral fuels; to hold meetings for social intercourse and the reading and discussion of papers on mineral economics; to encourage and assist in arranging for the inclusion of meritorious papers and discussions on mineral economics on programs of Regional, Divisional, and Annual Meetings of the Institute; and to arrange for the preparation of suitable economic and political papers dealing with minerals, having broad coverage of the industry—domestic and worldwide—for publication and distribution by the Institute." No conflict was seen by the Board in the professed aims of the Division with the Institute's policy on controversial matters as adopted by the Board at its Feb. 21, 1933, meeting, and printed in the current Directory on page 85. It was suggested that the papers of this Division might be published in Section 2—the All-Institute Section—of the monthly journals unless they covered only the specific field of one of the Branches.

The preliminary budget for 1949 as presented to the Board by Mr. Daveler, chairman of the Finance Committee, was, for the first time, arranged according to Branches, in line with suggestions made by the Petroleum Division that such an allocation be made so that it would be evident which fields of Institute activity were showing a profit, if any, and which a loss. The proper ratio of membership between the three Branches cannot yet be fixed, as many members have not yet indicated their primary choice of a monthly journal for the coming year, but the Mining Branch was estimated to have 52 per cent of the membership, and the Metals and Petroleum Branches each 24 per cent. These ratios will be changed, when more returns are in, for the final budget to be adopted later. This preliminary budget showed, for the Petroleum Branch, income of $90,476 and expenses of $118,018; for the Metals Branch, income of $78,330 and expenses of $112,403; and for the Mining Branch, income of $220,443 and expenses of $194,771. The over-all income budgeted for the year is $369,250, and expenditures, $425,192, or a prospective deficit of some $56,000. Two new staff members were provided for in the budget—an assistant editor for the petroleum journal, and another man to serve the Mining Branch as editor or field secretary or both.

An interim auxiliary publications committee of the Extractive Metallurgy Division was approved as follows: Carleton C. Long, chairman, Hugh M. Shepard and John D. Sullivan. Also the following auxiliary publications committee for the Petroleum Division was approved: Gordon H. Fisher, chairman; Owen F. Thornton, vice-chairman; J. Daviss Collett, K. C. Howard, Paschal Martin, and J. A. Slicker.

Appointments of AIME representatives on various committees and organizations were made as follows: Council of the American Association for the Advancement of Science, C. H. Mathewson and Donald H. McLaughlin; Seeley W. Mudd Memorial Fund, Wilber Judson; Engineering Societies Monographs, Reed W. Hyde; Engineering Index, Landon F. Strobel; Mining Standardization, ASA, Benjamin F. Tillson and Robert H. Morris; Pressure Piping, ASA, R. E. Crockett and Clarence M. Haight; American Year Book Corp., Bradley Stoughton.

Michael Tenenbaum was reported as having been selected to receive the Robert W. Raymond Memorial Award at the Annual Meeting.



THE DRIFT OF THINGS

. . . as followed by EDWARD H. ROBIE

Mining's Biggest Year

Mineral production in the United States reached an all-time peak again in 1948, according to data released at the end of the year by the Bureau of Mines. The tonnage of mineral fuels produced increased 4.8 per cent over 1947, other nonmetallic minerals 4.7 per cent, and metals 2.9 per cent. Expressed in value of output the figures were even more striking, of course, because of inflation, the total value of the mineral output being 15.6 billion dollars compared with 12.4 billion in 1947, an increase of 26 per cent.

The iron and steel industry operated at near-peak levels during most of the year and registered a 3½ per cent gain in output, at 88,000,000 tons of ingots and castings, but still this was only the third best year in the history of the steel industry. Strikes held back copper, lead, and zinc production so that output for the year was below that of 1947 by 1, 6, and 4 per cent respectively. Aluminum production achieved a new peacetime high but was a third below 1944. Gold output fell off 5 to 10 per cent because of higher costs and a fixed price for the product but the 90½-cent price of silver for the full year raised output of that metal by 5 per cent. Mercury production dropped sharply—to 13,950 flasks—because of imports at low prices, and at the end of the year only two companies were still operating.

Crude oil production gained 8 per cent, exceeding 2,000,000,000 barrels for the first time, at an average price of $2.59 per barrel. Ten per cent more natural gas was marketed. Bituminous coal and lignite output, at 596,000,000 tons, was down 5 per cent from the 1947 record because of a strike in March and April and reduced demand in the latter half of the year. Soft coal averaged $4.87 a ton at the mine. Anthracite, 57,000,000 tons, was about the same as in 1947, worth about $8 a ton.

Among the nonmetallics, all-time record shipments were made of sulphur, lime, salt, phosphate rock, potash, cement, gypsum, stone, kaolin, barite, talc, boron minerals, and vermiculite.

Many nonferrous metal mines, though enjoying high prices for their product, were prevented from setting new records in production during 1948, owing to strikes and a continued shortage of underground labor, but the Lake Superior iron mines, highly mechanized, were more fortunate. Vessel shipments down the Great Lakes totaled 82,937,291 long tons of ore (moisture included). This is a record for peacetime, and not greatly below the all-time high of 92,076,781 long tons reached in 1942. If high-grade iron ore reserves of the Lake Superior region are rapidly nearing exhaustion, that fact apparently has not yet acted as a brake on output.

Our Growing Institute

Along with its monthly bills, the telephone company sends little pamphlets concerning its service, and we are tempted to paraphrase the latest of these we have received, making it apply to the service the Institute gives:

There are lots of "hidden values" in your AIME service that can't be measured entirely in dollars and cents. There's the prestige of being a recognized member of your professional fraternity, the privilege of attending its meetings, of writing papers for its publications, or working with others on its committees. All these hidden values grow every time a new member is added to the roster. For it's pretty obvious that the more people that you can thus associate with, and who can associate with you, the more your membership is worth. So you'll be interested to know that, in the last fourteen years, more than 8000 members, net, have been added to the rolls, an increase of 118 per cent.

A New Commercial Metal?

Most of the metals commonly used were known and used hundreds, and some thousands, of years ago; a few, like aluminum, magnesium, and nickel, have achieved commercial importance only in the last 50 or 75 years. Is titanium destined to be the latest addition to the list of new and important metals?

The question is suggested by the expected early development of an immense body of titanium ore in Quebec, and of the good possibility that other deposits may be found, for the metal is supposed to be the seventh most common one in the earth's crust. Since the recent development of another large ore body in the Adirondack Mountains of New York State, titanium has been chiefly used in the oxide form as a white pigment, usually combined with zinc and lead in paint. It has also been on the market as ferrotitanium, but its use as a pure metal has been rare. The first such application that we can remember was as a filament in incandescent lamp

bulbs, a few such lamps being used about the time the carbon filaments were going out and the tungsten lamps coming into use.

The du Pont Company now has a pilot plant in operation with a capacity of 500 lb of titanium metal per day. The price is said to be $5 per pound, which would be excessive if the metal were made according to well-known production processes, but it is entirely within the realm of possibility that this figure could be shaded considerably if a new or improved process were developed, and commercial production on a large scale were carried on. Aluminum once sold for some such fancy price. Strength and corrosion resistance of titanium are comparable with stainless steel, under some conditions, at half the weight. It is less than twice as heavy as aluminum, but is about forty per cent stronger. It has a high melting point, and may find use in jet power plants and in the development of atomic power. A whole new family of titanium alloys is predicted.

News from Europe

Excerpts from a letter dated Nov. 16 from a friend who recently attended the Geological Congress in England, and has since traveled across the Continent to Italy:

Since arriving in Italy six weeks ago we have moved several times and I assure you that house-hunting in the smaller towns of this country is a bit of a problem though we've found fairly comfortable accommodations so far. We've been amazed at the recovery Italy has made. Factories are working and the railroads and highways carry a constant stream of freight. Out in the country the fields are teeming with people and everyone looks well. Some of the larger cities are a bit rugged, and there one sees some underfed and poorly clothed people. Food is plentiful and good although the Continental breakfast of coffee and a piece of bread makes us dream about hot cakes, bacon and eggs, etc. The highways are remarkably good, and a network of excellent secondary roads spreads out from the main trunk lines. However, don't take too much stock in all you hear about "sunny Italy." We're about to freeze to death most of the time, especially when we sit in an unheated room and look towards the snow-capped Apennines. All in all, Italy has been a pleasant surprise, but we'll be plenty ready to start home.

After the Geological Congress in London we took the two weeks' excursion to the Scottish Highlands. Up there we tried to keep up with Sir Edward Bailey, 67 years old, a rugged Scotch geologist who has spent his life in the Highlands and thinks nothing of taking a dip every frosty morning in the nearest loch. We managed to stay alive by huddling in wool shirts and raincoats. Stern, rocky mountains wreathed in almost perpetual mist, and pounded by howling gales with stinging rain thrown in your face while you climb 3000 ft to see some of the world's most complex geology—that's our impression of Scotland. And through all this stalked Sir Edward Bailey, bald head streaming with raindrops just about freezing, and clad only in shorts and a coat. It made me realize what fifteen years in the tropics does to your blood.

From England we crossed over to France, but only passed through. Had two weeks in Switzerland—our favorite of them all in every respect—food, people, and geology. From Zurich we drove through the Gothard Pass and so to Italy.

Let's Be Fair

That excellent weekly covering the Canadian mining industry, *The Northern Miner*, publishes the following editorial, based on ours in the December M&M:

Publications Should Stand On Own Feet

"Admission that the publication of *Mining and Metallurgy* has cost the AIME an average loss of $7,100 a year from 1920 to 1947 is made in announcing a reshuffle of the American institute's publicacions. The announcement confesses that the magazine when it sought greater advertising support met with opposition from the *Engineering and Mining Journal*. Now it is on the friendliest of terms with others papers in the mineral field, so it says, and adds that magazine publishing by professional societies has become 'generally accepted.'

"It is to be doubted whether such competition is truly accepted, except out of politeness. Mining journals that must appeal for subscriptions and advertising on their intrinsic usefulness to the public are able to assist the growth of their industry. The kind of competition which can afford large annual losses takes from commercial journals revenue which could be applied to enlarging the field of employment and advancement of professional men."

The writer of the above makes no mention of the fact, as plainly stated in the editorial on which he comments, that the average annual "loss" of $7,100 on M&M was incurred without any credit for subscription fees from members. If something like one dollar per year were allowed for a subscription fee, the magazine would have about broken even, and at the $1.50 rate nominally allowed for members' subscription fee to M&M through most of its history, a substantial profit would have been made. We wonder if *The Northern Miner* and other publications in the mining field would not also show a "loss" if they received no income from subscriptions.

Also, the implication is made in the above editorial comment that the publications of the AIME are not intrinsically useful and do not assist the growth of the industry they serve; that only "commercial" journals "enlarge the field of employment and advancement of professional men." We simply do not think this is so. We believe both professional society and privately published papers and magazines promote the advancement and the good of the professional men and the companies engaged in the industries they serve. One difference is that in the case of the professional societies no outside stockholders get any part of the profits that may be derived from such service. Certainly a part of the increased profit that private publications would make if they had no competition from society publications would go to their stockholders, whereas all the income received by the publications of the professional societies is a credit against their cost of operation, either acting as a brake on increases of dues, or making it possible for the members to get more for their money.

RICHARD J. ENNIS

Director, AIME

With but two geographical hops and one professional stint, Richard J. Ennis landed in the Porcupine district of Ontario. And although he remained stationary after this seven-league-boot sprint of 38 years ago, he managed to build up an éclat that has spread his name round the world. This feat of repose was accomplished at his Schumacher retreat by doing the work of the vice-president and general manager of McIntyre Porcupine Mines, Ltd.; of a councillor, vice-president, and president, successively, of the Canadian Institute of Mining and Metallurgy; and of a leader in the research that led to a preventive of silicosis.

It all started in Sheffield, Ill., where he was born in 1881. The next stop was the Smuggler Mining Co. of Aspen, Colo., to spend six years learning, at first hand, the art of the miner and millman. Then, a lord in the industry of those days who was duly impressed by Mr. Ennis's show of competence and enthusiasm invited the self-made man to design, erect, and operate a ten-stamp mill for a prospect in the Porcupine wilderness. With his acceptance, in 1911, came the development of what today is recognized as McIntyre Porcupine Mines, Ltd.

The story that fills the intervening years is marked by Mr. Ennis's own personality. Under his leadership the company sank twelve shafts—one to a depth of 7025 ft; built a 2450-ton flotation and cyanidation plant; and established McIntyre Research, Ltd., through which aluminum therapy was developed as a silicosis preventive.

A more precise appraisal of Mr. Ennis would be that offered by an old colleague:

"Starting out on his own in early life, he has, through constant study and successful experience, acquired an extraordinary knowledge of all things pertaining to the mining industry. He can hold forth with authority on what are the essential characteristics of a good mine hoist, the proper way to plan a stope or float gold, and, in the same tempo, switch into a description of a human lung—how fine silica particles attack it and how aluminum dust prevents the formation of silicic acid, and thus, with the elimination of dust so far as is possible and the use of the aluminum powder, how silicosis may be controlled and probably eliminated.

"In character, he is the happy, buoyant, friendly type of man—the perfect host. He is the typical leader, with great vision and the courage and energy to evolve new methods and then follow them through to a successful conclusion. I would say he is an out-and-out Irishman with almost all the characteristics peculiar to one of that race, and which include, in addition to those above described, the qualities of modesty and warm sympathy for those in trouble or distress."—*H.K.*

Malcolm Pirnie Receives Hoover Medal

Malcolm Pirnie, consulting engineer and head of the firm of Malcolm Pirnie Engineers, New York, has been named 1948 winner of the Hoover Medal, jointly awarded by four national engineering societies, Scott Turner, chairman of the Hoover Medal Board of Award, has announced. The award, one of the outstanding honors of the engineering profession, is in special recognition of Mr. Pirnie's leadership in the formulation of a program, sponsored by the Engineers Joint Council, for the postwar industrial control of Germany and Japan.

The medal was conferred at the Hotel Commodore, New York, on Jan. 19, the opening day of the 96th annual meeting of the American Society of Civil Engineers, of which Mr. Pirnie is a past president. The citation read: Malcolm Pirnie, engineer, leader of engineers and servant of his fellow man, whose ideals and accomplishments in public life beyond the call of his profession have benefited men in his own and other countries of the world, is awarded by his fellow engineers the Hoover Medal for 1948.

The program for the industrial disarmament of the aggressor nations, in which Mr. Pirnie played a leading part, was a voluntary contribution of the engineering profession toward world peace. It was carried on by the EJC through its National Engineers Committee, with Mr. Pirnie as chairman. Five national engineering societies are represented on this council.

The program for Germany got under way in 1944. It stated one clear objective: "an effective industrial means to keep Germany from starting another war." Removal of the plant and source materials essential to war was advocated but "with the least disturbance to the normal economy of western Europe." The program opposed "any plan which would make postwar Germany a drag on the economy of all Europe, if not of the world, and a breeder of future wars."

Later a similar report was prepared on the industrial disarmament of Japan. These reports, with their factual and scientific approach to the world recovery program, were approved in principle and in their main essentials by the State Department and Allied Control Council.

Winners of Student Paper Contests Announced

A telegram has just reached us before we go to press from C. B. Carpenter, chairman of the Student Prize Paper Contest Committee, announcing the winners of the 1949 contest. Winning first place in the graduate paper contest is W. E. Ellis, University of Illinois, and second place goes to F. J. Radavich, Purdue University. Winners in the undergraduate contest are: D. W. Pettigrew, Jr., Carnegie Institute of Technology; J. B. Seabrook, MIT; and G. T. Horne, Montana School of Mines. All were invited to receive their awards at the Annual Meeting in San Francisco.

First Pan-American Engineering Congress Planned

In an effort to establish closer relations between engineers in the Americas for their mutual benefit, the South American Union of Engineering Associations has decided to hold, in co-operation with engineering associations throughout the Americas, the First Pan-American Engineering Congress, from July 15 to 24, 1949, in Rio de Janeiro. Members of the AIME are cordially invited to participate by presentation of papers and attendance.

Of particular interest to members of the AIME will be sessions on fuel, mining engineering, geology, and metallurgy. Papers must be submitted by April 30. Copies of the agenda may be obtained from the Engineers Joint Council, 29 West 39th St., New York 18.

Calendar of Coming Meetings

FEBRUARY

1 Society for Applied Spectroscopy, 68 Park Row, New York City, 8 p.m. F. Nolan, on fluorescence.
2 Chicago Section, AIME. S. J. Creswell, on the Bessemer process.
3 Reno Branch, Nevada Section, AIME.
4 Columbia Section, AIME.
7 Boston Section, AIME.
8 East Texas Section, AIME.
9 El Paso Metals Section, AIME.
11-12 Association of American State Geologists, San Francisco.
11-12 New Mexico Miners and Prospectors Assn., Santa Fe.
14 Mid-Continent Section, AIME.
14-17 Annual meeting, AIME, Fairmont Hotel, San Francisco.
15 Gulf Coast Section, AIME.
15 Washington, D. C., Section, AIME.
16 Southwest Texas Section, AIME.
17 Carlsbad Potash Section, AIME.
17 North Pacific Section, AIME.
17 Utah Section, AIME.
18 Oregon Section, AIME.
21 Detroit Section, AIME. C. Lipson, on stress analysis.
22 Montana Section, AIME.
28 Alaska Section, AIME.
Feb. 28-Mar. 4 ASTM, spring meeting and committee week, Hotel Edgewater Beach, Chicago.

MARCH

2 Chicago Section, AIME. J. R. Van Pelt, Jr., on mineral economics.
3 Reno Branch, Nevada Section, AIME.
3-5 Symposium on Southeast mineral resources, University of Tennessee, Knoxville.
4 Columbia Section, AIME.
7 Boston Section, AIME.
8 East Texas Section, AIME.
9 El Paso Metals Section, AIME.
9 San Francisco Section, AIME.
10-12 American Physical Society, Division of Solid State Physics, annual meeting, Hollenden Hotel, Cleveland.
14 Mid-Continent Section, AIME.
14-17 American Association of Petroleum Geologists, annual meeting, Hotel Jefferson, St. Louis.
15 Gulf Coast Section, AIME.
15 Washington, D. C., Section, AIME.
16 Southwest Texas Section, AIME.
17 Carlsbad Potash Section, AIME.
17 North Pacific Section, AIME.
17 Utah Section, AIME.
18 Oregon Section, AIME.
21 Detroit Section, AIME. R. K. Hopkins, on the Kellogg process.
22 Montana Section, AIME.
28 Alaska Section, AIME.
Mar. 29-Apr. 1 Annual Safety Convention and Exposition, Hotel Statler (Pennsylvania), New York City.

APRIL

5-6 Metal Powder Assn., 5th annual meeting and exhibit, Drake Hotel, Chicago.
11-14 National Assn. of Corrosion Engineers, 5th Annual Conference and Exhibition, Netherland-Plaza, Cincinnati.
18-20 Midwest Power Conference, Sherman Hotel, Chicago.
18-20 Open Hearth Conference, and Blast Furnace, Coke Oven and Raw Materials Conference, Palmer House, Chicago.
24-28 American Ceramic Society, national meeting, Netherland-Plaza, Cincinnati, Ohio.

MAY

2-5 American Foundrymen's Society, 53rd annual meeting, St. Louis.

SEPTEMBER

25-28 Regional Meeting, AIME, Neil House, Columbus, Ohio.

OCTOBER

17-19 Institute of Metals Division, AIME, fall meeting, Cleveland.

DECEMBER

8-10 Seventh Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.

FEBRUARY 1950

12-16 Annual Meeting, AIME, Statler (Pennsylvania) Hotel, New York City.

APRIL 1950

10-12 Open Hearth Conference, and Blast Furnace, Coke Oven and Raw Materials Conference, Netherland-Plaza Hotel, Cincinnati.

DECEMBER 1950

7-9 Eighth Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.

What Went on at Recent Local Section Meetings

SECTION	DATE	PLACE	PRESIDING OFFICER	ATTENDANCE	SPEAKER, AFFILIATION, AND SUBJECT
Arizona	Oct. 20	Pioneer Hotel, Tucson		23	W. E. Wrather, President, AIME. Institute Affairs.
Black Hills	Dec. 9	South Dakota School o Mines, Rapid City			Business meeting.
Boston	Dec. 6	Metals Processing Laboratory, MIT	George P. Swift	55	Howard F. Taylor, associate professor of mechanical engineering, MIT. Renaissance of the foundry.
Carlsbad Potash	Dec. 14	Riverside Country Club	R. H. Allport	120	Social meeting.
Colorado	Dec. 17	University Club, Denver	M. I. Signer	57	Steve Arrick, Le Panto Consolidated Copper Co. Present conditions in the Philippines.
Columbia	Oct. 1	Spokane	J. W. Melrose	15	Field trip to Trentwood aluminum rolling mill, Permanente Metals Corp.
Columbia	Nov. 5	Spokane	Harold Culver	20	Film, "An Ore Sample," American Cyanamid Co.
Delta	Dec. 7	Petroleum Club, New Orleans	J. C. Posgate	50	L. V. McConnell, Lane Wells Co. Engineering of well depth measurements.
Detroit	Nov. 22	Detroit	C.L. Raynor	100	F. N. Rhines, associate professor of metallurgy, Carnegie Institute of Technology. Sintering of metal powders.
El Paso Metals	Dec. 8	El Paso			L. J. Russel, Paul E. Ayers, and M. E. Alarcon USNR, El Paso district. U. S. Navy in World War II.
El Paso Metals	Dec. 17	Biltmore Hotel, El Paso		70	Social meeting with Woman's Auxiliary.
Lehigh Valley	Dec. 6	Bethlehem	M. L. Fuller	125	W. E. Wrather, President, AIME. Recent trip to the Near East.
Mid-Continent	Dec. 13	Tulsa	John P. Hammond	117	P. P. Scott, Jr., Stanolind Oil and Gas Co. Factors to be considered in obtaining proper cementing of casing.
Montana	Dec. 8	Finlen Hotel, Butte	H. G. Satterthwaite	92	Business meeting.
North Pacific	Dec. 16	Rose's Highway Inn, Seattle		60	E. N. Patty, president, Alluvial Gold, Inc. Placer prospecting as an aid to lode discovery.
Tri-State	Dec. 1	Tri-State Zinc and Lead Ore Producers Assn., Picher	O. W. Bilharz	6	Business meeting.
Tri-State	Dec. 8	Picher	O. W. Bilharz	55	Jack Pulliam, Allis-Chalmers Mfg. Co. Atomic bomb test at Bikini.
Wyoming	Dec. 11	Park Hotel, Rock Springs	H. C. Livingston	20	M. M. Fidlar, chief geologist, Mountain Fuel Supply Co. Church Buttes gas field.

New Local Section Officers

ALASKA SECTION . . .

Ted C. Mathews, Chairman; Patrick H. O'Neill, Vice-Chairman; Ralph B. Norris, Secretary-Treasurer; Leonard M. Berlin, Vice-Chairman for Juneau; Harold Strandberg, Vice-Chairman for Anchorage; Frank E. Love, Vice-Chairman for Nome.

BLACK HILLS SECTION . . .

Fremont Clarke, Chairman; Paul Gries, First Vice-Chairman; J. O. Harder, Second Vice-Chairman; A. L. Slaughter, Secretary-Treasurer; Renaldo Gallo, A. B. Needham, and Albro Ayres, Executive Committee.

CARLSBAD POTASH SECTION . . .

J. P. Smith, Chairman; G. E. Atwood, First Vice-Chairman; E. W. Douglass, Second Vice-Chairman; John Nutt, Secretary-Treasurer.

COLORADO SECTION . . .

M. I. Signer, Chairman; J. W. Vanderwilt, Vice-Chairman; J. Paul Harrison, Secretary-Treasurer; E. D. Dickerman, C. E. Dobbin, M. H. Robineau, E. J. Eisenach (Climax Subsection), and H. S. Worcester (San Juan Subsection), Directors.

DELTA SECTION . . .

E. N. Dunlap, Chairman; H. M. Krause, Jr., and C. R. Blomberg, Vice-Chairmen; Fred E. Simmons, Secretary-Treasurer; Paul Ratliff, Junior Secretary; B. C. Craft and H. C. Petersen, Directors.

LEHIGH VALLEY SECTION . . .

F. E. VanVoris, Chairman; R. T. Gallagher, B. J. Larpenteur, and Robert B. Hoy, Vice-Chairmen; W. S. Cumings, James Guider, and M. L. Fuller, Managers.

MONTANA SECTION . . .

J. Hollis McCrea, Chairman; J. P. Spielman, Vice-Chairman; F. W. Strandberg, Secretary-Treasurer; Kuno Doerr, Jr., and E. C. Van Blarcom, Executive Committee.

NORTH PACIFIC SECTION . . .

Kenneth H. Anderson, Chairman; L. W. Heinzinger, Vice-Chairman; W. C. Leonard, Secretary-Treasurer.

TRI-STATE SECTION . . .

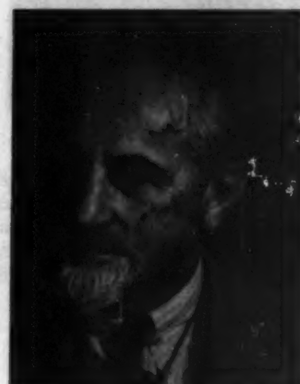
Harold A. Krueger, Chairman; Ernest Blessing, Vice-Chairman; J. C. Stipe, Secretary-Treasurer; Ernest Blessing, F. J. Cuddeback, O. W. Bilharz, H. A. Krueger, C. Y. Thomas, G. M. Fowler, Elmer Isern, and J. P. Lyden, Directors; S. S. Clarke, Chairman, O. W. Bilharz, G. M. Fowler, and Dan Stewart, Program Committee; Ernest Blessing, Chairman, Curtis Stover, E. H. Crabtree, and R. K. Stroup, Membership Committee.

UTAH SECTION . . .

J. C. Landenberger, Jr., Chairman; Byron E. Grant, Vice-Chairman; R. C. Cole, Secretary-Treasurer.

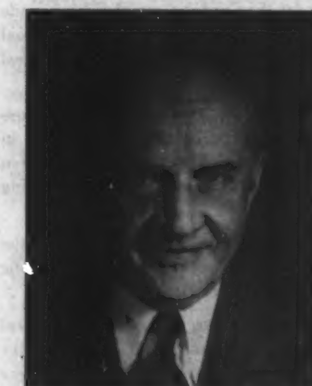
News of AIME Members

Oliver Bowles



© Erles C. Anderson

John Van Nostrand Dorr



© Erles C. Anderson

Elmer R. Ramsey

Oliver Bowles was presented with the Gold Medal of the Department of the Interior on Dec. 15. The citation for distinguished service upon completion of 33 years of continuous service with the Federal Government reads: During his 33 years with the Bureau of Mines, he strongly influenced the growth of its work in the technology and economics of nonmetallic minerals. Author of more than 250 publications, 153 of them official publications of the Bureau, covering the broad field of nonmetallic minerals, and of a standard textbook, "The Stone Industries," he won international recognition as an authority on mining and quarrying. By introducing the wire saw, he enabled the American slate industry to expedite production, reduce waste, and cut costs. During the war, his opinion and advice on many problems involving nonmetallic minerals were eagerly sought by and freely given to the Government's war agencies. From 1914, when he became the Bureau's first quarry technologist, to Jan. 31, 1947, when he retired as chief of the nonmetallic minerals economics branch, Dr. Bowles served the nation with zeal, integrity, and distinction that entitle him to the highest commendation of this Department.—*J. A. Krug, Secretary of the Interior.*

John Van Nostrand Dorr, chemical, metallurgical, and industrial engineer, prolific inventor and founder of The Dorr Co., New York City, and five associated companies in Europe, has been elected to the newly created office of chairman of the board. **Elmer R. Ramsey,** who has been connected with the Company for 34 years, filling various positions, and more recently operating vice-president, became president. These changes became effective Jan. 20. He continues as chairman of the board of directors of Dorr-Oliver Co., London.

The Dorr Co. was started some forty years ago, literally as a 'one-man' organization, to apply a succession of inventions made by Dr. Dorr in plant operation in the Black Hills of South Dakota. The rest of the story is familiar—the 'one-man' organization gradually becoming an expanding engineering group. The Company's new inventions and new applications of the old carried it from its original metallurgical field through sugar and sanitary engineering and into the chemical industries and geographically pretty well around the globe. The present step in the development of its management is another step in the company's expansion and development.

Dr. Dorr's life has been one of engineering alertness, prolific inventiveness, and originality, in not one field but many, leading to industrial success, as well as full professional and academic recognition for his many and varied technical achievements. His own 26 inventions, notably the Dorr classifier, Dorr thickener, and Dorr agitator and modifications thereof, plus those of his staff, have been applied successfully in over a hundred separate and distinct processing industries. They have made it possible to convert intermittent chemical processes to continuous ones; they have contributed to the large-scale, low-cost exploitation of low-grade ore deposits; they have contributed to placing municipal and industrial sewage and water treatment on a sound engineering basis, to the benefit of the public health at home and abroad.

Mr. Ramsey became associated with Dr. Dorr in 1913, soon after graduation from the Colorado School of Mines. He started on design and test work in the Black Hills, and then took the job of junior engineer at the Denver plant. By 1927 he was in New York, where he became, consecutively, assistant general sales manager, executive assistant to the president, vice-president in charge of engineering department, operating vice-president, and now president.

Howard O. Gray resigned as mining editor of the *Joplin Globe* and *News Herald* and as secretary of the Tri-State Zinc and Lead Ore Producers Assn. on Dec. 1. He plans to engage in private business.

Robert B. Hall, geologist with the U. S. Geological Survey, has been transferred from Spread Eagle, Wis., to Grand Junction, Colo., P. O. Box 337.

R. J. Horsman is chief engineer for Day Mines Inc., Wallace, Idaho. His mail address there is 305 3rd St.

Donald C. Howe, former field supervisor for the Cardox Corp., has been made assistant mine foreman of the Vesta coal division of the Jones and Laughlin Steel Corp., California, Pa.

Carlton D. Hulin visited Institute headquarters during December while in New York on business for the Tungsten Mining Corp. for whom he is consulting geologist.

Danforth Jackson has a job in the geology department of the Republic Steel Corp., Port Henry, N. Y.

L. R. Jackson, who has been general manager of Ariston Gold Mines (1921) Ltd., is chairman and general manager of the Cyprus Sulphur and Copper Co., Limni Mines, Polis, Cyprus; the Company is engaged in reopening a mine formerly worked by the Phoenicians and Romans for copper.

William Karsten is mine shift boss for Cia. Huanchaca de Bolivia, Pulacayo, Bolivia.

Harry W. Kemery is assistant to the superintendent of the Tamaqua district of the Lehigh Navigation Coal Co., Lansford, Pa.

M. H. Kline for the past three years has been working with the Bureau of Mines. He is chief of the special minerals investigation branch at Mt. Weather, Bluemont, Va.

Simon Lake, III, has returned from Felton, Oriente, Cuba, where he was with the Juragua Iron Co., and can be reached at 1313 Fairmont Ave., Fairmont, W. Va.

T. F. Maddick, formerly with the St. Joseph Lead Co., is now employed by the Anaconda Copper Co., Butte, Mont., in the mechanical engineering department.

Samuel A. Madrid is vice-president and manager of the Hamilton Equipment Co., 257 Rio Grande St., Salt Lake City. He was with the Smith Engineering Works in Milwaukee.

Burt C. Mariacher, who was addressed in care of the Consolidated Feldspar Corp., Parkdale, Colo., is now reached in care of the Western-Knapp Engineering Co., 50 Church St., New York City 7.

Ernest N. Patty

Ernest N. Patty, president and general manager of Alluvial Golds Inc. and Gold Placers Inc., returned to his Seattle office last fall after spending the summer in Alaska and the Yukon Territory supervising gold dredging operations there.

Elmer Isern

Elmer Isern, who has been active in mining operations in the Tri-State district for more than twenty years, has been elected president of the Eagle-Picher Mining and Smelting Co., a subsidiary of the Eagle-Picher Co. Mr. Isern, a native of Ellinwood, Kans., and a graduate of Kansas University, worked for several years in Montana and California before going to Miami, Okla., as metallurgist and general milling superintendent for the Commerce Mining and Royalty Co. In 1939 he joined Eagle-Picher as metallurgist and general milling superintendent.

George P. Lutjen joined the staff of the *E&MJ* as assistant editor on Feb. 1. He had been a mining engineer for the Freeport Sulphur Co. since 1943 except for two years which he served with the Marine Corps in China. Mr. Lutjen is a graduate of the Columbia School of Mines.

H. Eugene Mauck recently accepted the post of assistant to the president of the Olga Coal Co. He was formerly superintendent of the Westland mine of the Pittsburgh Coal Co. His headquarters are in Cleveland in the Union Commerce Bldg. and his work takes him to the operations in southern West Virginia. There are three mines operating near Welsh, two of which mine the Pocahontas No. 4 seam and one of which mines the War Creek of Beckley seam with a total annual production of about 2,500,000 tons. Upon graduation from Penn State in 1939, Mr. Mauck entered a training program with the Pittsburgh Coal Co. He served as mine superintendent for that company for about six years.

John D. McAuliffe has been made mine superintendent of Falconbridge Nickel Mines, Ltd., Falconbridge, Ont.

Francis J. McCavitt, formerly a student at the New Mexico School of Mines, is chief of party of a U. S. Geological Survey topographic branch, Box 2858, Lakewood, Colo.

Vernon L. McCutchan, formerly assistant general manager of the Cerro de Pasco Copper Corp., Oroya, Peru, is now addressed at 140 5th St. W., Dickinson, N. Dak.

A. R. McGuire is president of the Fresno Mining Co., 415 Brix Bldg., Fresno, Calif., which operates the Strawberry tungsten mine.

A. L. Minter has taken a job as chemical engineer for the Loceria Colombiana, Medellin, Colombia, and is also engaged in mining consulting work.

Harry W. Montz left for Shanghai, China, on Dec. 8 as a representative of the J. G. White Engineering Corp. in connection with development of China's resources. He expects to be gone from one to one and a half years.

William P. Morris is research engineer at the research laboratory of the Oliver Iron Mining Co., 4832 Grand Ave., Duluth 7, Minn.

Garrett A. Muilenburg, who has been professor of geology at the Missouri School of Mines, has joined the staff of the Missouri Geological Survey, Rolla.

Randall T. Murrill, who has been local superintendent for the Mine La Motte Corp., is now general mine superintendent for the St. Joseph Lead Co., Bonne Terre, Mo.

Kenneth W. Nickerson, Jr., after graduation from the Colorado School of Mines last July and a short vacation at his home in Riverside, Calif., reported to work as a geologist for the Kennecott Copper Corp., Ray mines division, Hayden, Ariz.

Edward S. O'Connor is vice-president of the Hi-Heat Coal Co., 1894 E. 39th St., Salt Lake City. He had been with the Columbia Steel Co.

W. T. Pettijohn resigned as mine superintendent with the Mufulira Copper Mines Ltd., Mufulira, N. Rhodesia, in September and returned to the States to take up employment with the New Jersey Zinc Co. at Austinville, Va.

Colwell A. Pierce has retired as general superintendent of the U. S. Potash Co., Carlsbad, N. Mex. **Henry H. Bruhn,** former refinery superintendent, has been made resident manager with general supervision of mining and refinery operations.

Leslie W. Pullen, who was with the Oliver Iron Mining Co., has gone to Holden, W. Va., to join the engineering department of the Island Creek Coal Co.

Mat Sample, who has been in Chuquicamata, Chile, with the Chile Exploration Co., can now be reached at East Moriches, L. I., N. Y.

Robert M. Shapiro is an instructor at Penn State Extension University, Dravosburg, Pa., and also a graduate student at the University of Pittsburgh. His address is 434 S. Graham St., Pittsburgh.

William Sharp has changed his address from Eureka, Nev., to 1073 E. 6th S St., Salt Lake City.

Paul L. Shields has resigned as president of the Sheridan-Wyoming Coal Co. and has accepted the presidency of three Utah coal companies, Spring Canyon Coal Co., Royal Coal Co., and Standard Coal, Inc. **Walter J. Johnson,** general superintendent of the Bell & Zoller Coal and Mining Co., succeeds Mr. Shields as president of Sheridan-Wyoming.

John F. Simpson, Jr., after graduation from Penn State, became employed by the Clearfield Bituminous Coal Corp. at Arcadia, Pa. His present address is 28 Herman St., Commodore, Pa.

J. D. Sperr has been made construction inspector for the City of Oakland, Calif. His address there is 3600 Victor Ave., Oakland 19.

Charles E. Stott, who was vice-president and general manager of Cia. Minera de Penoles, division of the American Metal Co., is engaged in consulting work in Monterrey, Mexico.

Guy C. Riddell

Guy C. Riddell returned to the States in October after a year in Korea where he acted as mining advisor to the National Economic Board, Military Government, and Korean Government. He is staying at his farm at Royal Oak, Md.

William D. Lord, Jr.

William D. Lord, Jr., is now mine superintendent for the International Mining Co., an enterprise of W. R. Grace & Co. of New York City, at its Chojilla mines.

Roy G. Stott has been transferred by the Bureau of Mines from the Duluth office to its district offices at Wilkes-Barre, Pa., in the anthracite coal mining area.

Lester S. Thompson returned several months ago from Germany, where he had been conducting special studies for the Department of the Army.

Thaddeus S. Ullmann is assistant manager of the export department of the Eimco Corp., manufacturers of mining equipment, New York and Salt Lake City. His home address is 68-49 Burns St., Forest Hills, N. Y.

H. van Arkel, prisoner of war in Sumatra, was repatriated to Holland in 1946, left that country for Dutch Guiana as an employe of the Billiton Co., and remained in Surinam for about a year as manager of the Billiton bauxite mines. He left Surinam in July 1948 for Celebes, Indonesia, where the Company was exploring nickel ore deposits. His address at present is Mijnbouw Mij "Celebes," Malili, South Celebes, Indonesia.

David L. Watts has been made smelter superintendent for the Calumet & Hecla Consolidated Copper Co.

Bleecker L. Wheeler, formerly senior engineer with Ford, Bacon & Davis Inc., has opened a consulting office at 217 Broadway, New York City 7, in mining and industrial engineering.

David White, former geologist with the Alcoa Mining Co., has joined the staff of the Oregon State Department of Geology and Mineral Industries.

John B. White, Jr., metallurgical engineer with the Galigher Co., has been transferred from Butte, Mont., to Salt Lake City, Utah.

Robert T. Williams, of the University of Arizona, has been awarded the $750 scholarship provided by the Kennecott Copper Corp. to a senior student at the College of Mines there who is majoring in mining engineering. The prize was awarded on the basis of character, scholarship, leadership, and initiative.

Frank R. Zachar is general superintendent of the Christopher Coal Co., Pursglove, W. Va. He had been with the Pursglove Coal Mining Co.

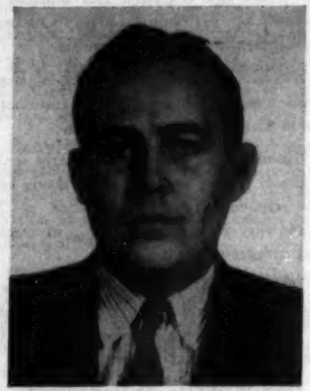
• In Petroleum Circles

Allen D. Acomb, petroleum engineer with The Texas Co., has been transferred to the Company's Erath cycling plant at Erath, La.

Charles D. Axelrod, of 2416 Fenwick Rd., University Heights, Cleveland 18, Ohio, is occupied chiefly by buying and selling aluminum flat stock for the Alloys and Chemicals Co., Cleveland.

Max W. Ball resigned as director of the oil and gas division of the Department of the Interior on Dec. 1, and returned to private consulting work with offices in Washington, D. C. He lives at 1648 Foxhall Rd. Mr. Ball has been director of the oil and gas division since December 1946 and has had active experience in nearly all phases of the oil and gas industries. He served as chairman of the oil board of the Geological Survey, as engineer and law officer of the Bureau of Mines, as manager of exploration in the

Rocky Mountain region for the Shell Oil Companies, as president of the Argo Oil Co. and affiliated producing and pipe line companies, and during the war was with the PAW as special assistant to the deputy administrator. He had been in consulting practice since 1928 when not in Government service.



H. D. Spires

H. D. Spires has been transferred from the Tidewater Associated–Seaboard New Hope field in Franklin County, Texas, where he served as district petroleum engineer, to Kamay, where he has assumed his duties as district engineer and acting district foreman over the Tidewater Associated Oil Co. operations in the Wichita Falls area. His address is Box 204, Kamay, Texas.

Richard A. Barton, Jr., is a petroleum engineer trainee with The Texas Co. at Fort Worth, Texas. His mail goes to 836 N. Grand Ave., Gainesville, Texas.

Robert C. Beck is resident petroleum engineer for Michigan for the Superior Oil Co. He is staying at the Stearns Hotel, Ludington, Mich. He had been with the Michigan State Conservation Dept.

Gordon K. Bell, Jr., who is a researcher for the American Petroleum Institute, receives mail at 1155 Park Ave., New York City.

Eugene P. Bowler, who was chief of naval operations (OP-32), Mail and Dispatch Section, Navy Dept., Washington, is now addressed at P. O. Box 296, Shidler, Okla.

L. G. Chombart is manager of the Kansas division of the Schlumberger Well Surveying Corp., P. O. Box 1034, Wichita, Kans.

W. A. Clark, Jr., manager, foreign producing for The Texas Co., can be reached at 135 E. 42d St., New York City 17.

T. Dudley Cramer recently received his M. S. degree in petroleum engineering from Stanford University and is now employed by the producing department of the Standard Oil Co. of California at Taft, Calif.

Albert W. Dauer has the job of junior petroleum engineer with the Stanolind Oil and Gas Co. He is staying at the James Hotel, 219 NW 4th St., Oklahoma City, Okla.

Marshall Dayton, Jr., formerly of Norman, Okla., is now addressed at Drawer H., in care of the Sun Oil Co., Premont, Texas.

Robert H. Dickey has been employed as district geologist at Worland, Wyo., by the Pure Oil Co. since last July. He was a student at the University of Minnesota.

Robert E. Fearon is laboratory director for Well Surveys, Inc., Tulsa. He lives at 1430 S. Terrace Drive, Tulsa, Okla.

Thomas C. Frick, with the Atlantic Refining Co., has been transferred from Odessa, Texas, where he was district superintendent, to the post of division operations supervisor at Midland.

James H. Galloway, who was with the Humble Oil and Refining Co., Florey, Texas, is now addressed at Rm. 517, Hollingsworth Bldg., Los Angeles 14.

Joseph W. Walton

Joseph W. Walton, upon separation from the Army last summer, took some courses in real estate law and real estate brokerage at the University of Florida, and opened a real estate brokerage office in Vero Beach, Indian River County, Fla., on Dec. 1. He has made Vero Beach, Fla., his permanent residence and it is quite possible that he may add an engineering division to his present real estate activities sometime in the near future.

Howard K. Grant, home address 10524 Dorothy Ave., South Gate, Calif., is working for the Western Gulf Oil Co., Los Angeles, as a petroleum engineer.

Willard J. Larson, former manager of field operations for the Union Oil Co. of California, is now with the Yellowstone Oil Co., 629 S. Hill St., Los Angeles 14.

B. C. McRee, who is with the Union Producing Co., has been transferred from the Gulf Coast division to Shreveport, La.

Nace F. Mefford, Jr., Missouri School of Mines man, is working with the Ashland Oil and Refining Co., Ashland, Ky. His new address is 512 Center St., Henderson, Ky.

LeMoyne W. Myers, who has been addressed in care of the Creole Petroleum Corp., Maracaibo, Venezuela, is now reached in care of the Socony-Vacuum Oil Co. of Venezuela, Apartado 246, Caracas, Venezuela.

John A. Newman has been made division reservoir engineer for the Houston division of the Shell Oil Co. His new address is 4604½ S. Main, Houston.

Daniel B. Nolan, who has been studying at the University of California, Berkeley, is working as assistant geologist for the Capital Co., Los Angeles.

Sylvain J. Pirson, formerly associate professor of petroleum and natural gas engineering in the School of Mineral Industries at Penn State, joined the engineering department of the Stanolind Oil and Gas Co., Tulsa, Okla., as research reservoir engineer in January.

F. O. Prior, who has been president of the Stanolind Oil and Gas Co., Tulsa, is vice-president in charge of production of the Standard Oil Co. (Indiana), Chicago.

Michael R. Rector has a job as petroleum geologist with the Union Oil Co. of California, 702 Washington St., Olympia, Wash. He had been a student at the University of Washington.

Forest B. Rees is a geological trainee with the Carter Oil Co., P. O. Box 801, Tulsa, Okla.

Clarence W. Sanders, who was chief geologist for the Danciger Oil and Refining Co., is a consulting geologist in oil and gas exploration and development, with an address at 2413 Colonial Parkway, Fort Worth 4, Texas.

Douglas L. Saunders, who had been studying at the A&M College of Texas, is a petroleum engineer with the Sun Oil Co., Box 1312, Gladewater, Texas.

Herman E. Schaller has been made division sales manager of the Rocky Mountain-Mid Continent division of the Eastman Oil Well Survey Co., 1360 Speer Blvd., P. O. Box 1500, Denver.

Gene L. Scheirman, until recently a student at the University of Oklahoma, is a junior exploitation engineer with the Shell Oil Co., Houston. He gets his mail at 1423 N. W. 33rd St., Oklahoma City, Okla.

Albert T. Sindel, Jr., is division engineer for the Bay Petroleum Corp., and receives mail at Rt. 3, Seymour Rd., Wichita Falls, Texas.

Norman Soul is working as a geologist for the Pacific Western Oil Co. in Calgary, Alta. He had been with the McColl-Frontenac Oil Co.

J. Claire Sowers, Jr., former student at Penn State, is addressed in care of the Phillips Petroleum Co., City National Bank Bldg., Houston 2, Texas.

Charles E. Sturz is a paleontologist with the Tidewater Associated Oil Co., San Francisco. He receives mail at 915 College Ave., Menlo Park, Calif.

• In the Metals Branch

Robert E. Anderson has completed work for a B.S. degree in physical metallurgy at the University of California in Berkeley and is now employed by the University.

Mary Baeyertz has been named assistant chairman of the metals research department of Armour Research Foundation of Illinois Institute of Technology. Dr. Baeyertz, author of the recently published book, "Nonmetallic Inclusions in Steel," has been with the Foundation as a senior metallurgist since March 1, 1947. Previously she was supervisor of research at the South works of the Carnegie Steel Corporation. Dr. Baeyertz received her master's and doctor's degrees from Columbia University. She was awarded her bachelor's degree from Smith College. In her new position, Dr. Baeyertz will assist **W. E. Mahin,** chairman of the department, in general scientific supervision of numerous fundamental and applied research programs for industry and government agencies.

James L. Baker, who had been mill metallurgist for the Seymour Mfg. Co., Seymour, Conn., has become chief metallurgist with the Phosphor Bronze Corp., 2200 Washington Ave., Philadelphia, Pa.

Richard F. Baley is sales engineer for the Illinois Clay Products Co., Chicago. His mail reaches him at 20700 Ridgewood Ave., Cleveland 22, Ohio.

John H. Becque is night superintendent at the Tacoma smelter of the American Smelting and Refining Co., Tacoma, Wash. He had been a student at MIT.

R. L. Hallett

R. L. Hallett retired as chief chemist for the National Lead Co. and is now practicing as a consulting engineer with Arnold H. Miller. His office is at Rm. 2518, 120 Broadway, New York City 5.

Allan L. Brooks, who was a junior research engineer for the Air Reduction Co., is now working as metallurgical engineer in the standards engineering laboratory of the Sperry Gyroscope Co., Lake Success, N. Y.

A. Clemes is chief consulting metallurgist for New Consolidated Gold Fields Ltd. Mail reaches him at Box 1167, Johannesburg, S. Africa.

Dillon Evers, formerly on the staff of Michigan State College, is now on the staff of the school of chemical and metallurgical engineering at Purdue University, W. Lafayette, Ind.

Clarence T. Fletcher, who had been with the research division of the Mack Mfg. Corp., has gone to Braeburn, Pa., to work with the Braeburn Alloy Steel Corp.

Frank Foote, who was associate professor at the Columbia School of Mines, is now addressed at the Argonne National Laboratory, P. O. Box 5207, Chicago 80.

C. W. Hayes, formerly with the Sherwin F. Kelly Geophysical Services, is now with the Aluminum Co. of Canada, Arvida, Que.

Ray E. Huffaker, formerly a student at Purdue, is assistant lubrication engineer for the Ladish Co., manufacturer of forgings, at Cudahy, Wis. Mail reaches him at 1813 S. 28th St., Milwaukee 4, Wis.

Ivor Jenkins, with the research laboratories of the General Electric Co., Wembley, England, has been awarded the degree of Doctor of Science by the University of Wales for work in the field of metallurgy.

James G. Johnstone is now on the staff of Purdue University as an instructor in geology in the school of chemical and metallurgical engineering.

Herbert S. Kalish, formerly with the Electric Storage Battery Co., Philadelphia, is now working with Sylvania Electric Products Inc., Sylvania Center, P. O. Box 6, Bayside, L. I., N. Y.

Francis M. Krill is research metallographer for the Permanente Metals Corp., Spokane. His address is W. 1028 19th Ave., Spokane 9, Wash.

George E. Linnert works in the research laboratories of the Rustless division of the Armco Steel Corp., Baltimore, Md.

Robert T. Luedeman, formerly with the Braden Copper Co., Rancagua, Chile, has a job as metallurgist with the Weston Electrical Instrument Co., Newark, N. J. He receives mail at 192 Hillside Ave., Leonia, N. J.

H. Gerald Maiers

H. Gerald Maiers until last August was with the engineering department of the General Chemical Co. At that time he joined the development engineering department of the National Lead Company's Titanium division, where he is now employed. His address is 23 Park Ave., Cranford, N. J.

M. Merlub-Sobel has been appointed to the newly created post of associate professor of chemical engineering and metallurgy at the Hebrew Technical College, Haifa, Israel, the only engineering and technological school in Israel, and, for that matter, in that part of the Near East. His present work, that of manager of one of the divisions of Machleket Ha-Yitzur, will continue simultaneously with teaching and consultation in the fields of chemical and metallurgical engineering.

Gordon M. Miner is sales engineer for the Goodman Mfg. Co. His home is at 812 Baver Ave., Charleston, W. Va.

Ralph L. Nelson, Jr., resigned from the Tennessee Coal, Iron and Railroad Co. on Nov. 30 to enter the employ of Thomas Foundries, Birmingham, Ala., as a chemist.

M. N. Ornitz is assistant superintendent of National Alloy Steel, division of the Blaw-Knox Co., Blawnox, Pa.

F. A. Paciotti has a job with the Tin Processing Corp., Texas City, Texas, as a research engineer. His mail reaches him at 4801–R½, Galveston.

John W. Russell, who had been studying at Carnegie Institute of Technology, is working as apprentice engineer for the Mesta Machine Co., West Homestead, Pa. His home address there is 4723 Brierly Court West.

Ralph Sheppard is working as a research engineer for the St. Joseph Lead Co. of Monaca, Pa. He was a student at the South Dakota School of Mines.

George E. Sibbett, who has been a partner in the Coulter Sibbett Steel Co., is president of the Allen Fry Steel Co., Los Angeles. His home address is 1126 Greenwich St., San Francisco.

T. J. C. Smid, formerly chief engineer of the metallurgy department of the Billiton Co., is now working for a Bolivian tin company and is addressed at Fundicion de Estano, Oruro, Bolivia.

Austen J. Smith left the Lunkenheimer Co. as assistant director of research Nov. 1 to become connected with Michigan State College at East Lansing as associate professor of metallurgical engineering.

H. D. Stark has retired as assistant to the vice-president in charge of operations of the Jones & Laughlin Steel Corp. For many years he was general superintendent of the Pittsburgh works. Mr. Stark has completed 49 years of service with J&L. He started at the age of sixteen as a draftsman in the engineering department of the Pittsburgh works. After serving as superintendent of the machine shop, the steel works, and the blooming mill departments, he was appointed assistant general superintendent of the Pittsburgh works in 1927. He served as general superintendent from 1936 until August 1947, when he was appointed assistant to the vice-president in charge of operations.

Wilfred Sykes, president of the Inland Steel Co., Chicago, has been representing the U. S. Army on a one-way commission to report on organization by the American and British commission. He made a trip to Germany and other spots in Europe in December.

Robert M. Wagner returned to Stanford University in 1946 to obtain his doctorate in organic chemistry. He is now research chemist for the General Electric Co. at the Hanford engineering works, Richland, Wash.

Walter M. Weil, who has been general manager of the National Smelting Co., is general manager of the Enesco Corp., producers of magnesium alloys, Box 1791, Cleveland 5, Ohio.

Clarence Zener, professor of metallurgy at the Institute for the Study of Metals, University of Chicago, is serving as special lecturer and consultant in physical metallurgy in the department of mining and metallurgical engineering of the University of Illinois. He delivered his first lectures Nov. 18 and 19 on "The Problem of Fraction" and "The Acoustical Spectrum of Metals." Dr. Zener, a native of Indianapolis, received his undergraduate degree at Stanford University and his doctor's degree at Harvard, and was successively Sheldon traveling fellow, National research fellow, research fellow of Bristol University, and instructor in physics at Washington University and at CCNY before becoming principal physicist of the Watertown (Mass.) Arsenal in 1942.

Obituaries

H. Clarence Horwood

An Appreciation by C. C. Huston

In the sudden death of H. Clarence Horwood in Vancouver, B. C., on Oct. 30, his many friends and the mining industry have suffered a real and grievous loss. "Clare"—as he was invariably known—had been enjoying a holiday at the coast when he died.

Born in Ottawa in 1905, his career and progress in the field of mining geology had been direct and constant. He had won academic recognition with a B.A.Sc. in geological and mining engineering, at the University of British Columbia in 1930; an M.Sc. in geological engineering, at Queen's University in 1931; and a Ph.D. in geological and mining engineering, at MIT in 1934.

In 1936 he was appointed assistant geologist on the staff of the Ontario Department of Mines, after gathering experience in field work with the Geological Survey of Canada in Alberta, British Columbia, and Manitoba; and during an interval of private practice in Great Bear Lake. In addition, he also acted as assistant geologist in the Bureau of Economic Geology, in Ottawa. In 1943 Clare was appointed district geologist for Northwestern Ontario, residing at Port Arthur, and in 1947 was recalled to the headquarters staff of the Ontario Department of Mines in Toronto. In the course of his expanding career with the Department, he did work that took him into the Casummit Lake, Superior Junction, Red Lake, Little Long Lac, and Missanabie areas. He was very active during the war years in the strategic mineral field.

His report on the "Geology and Mineral Deposits of the Red Lake Area," a publication of the Ontario Department of Mines, is an outstanding contribution to Canadian geological knowledge. Although he was the author of more than thirty other papers and articles of great interest, the Red Lake report is the most outstanding, from every aspect, demonstrating as it does the basic knowledge of the writer, making a clear exposition of the information so meticulously gathered, and more particularly reflecting the calm confidence which the writer so obviously felt in his work and the future of this area and country.

His devotion to the interests of his profession is best demonstrated by briefly recounting his affiliation with the AIME, the Society of Economic Geologists, the Association of Professional Engineers of the Province of Ontario, and the Prospectors and Developers Association. In proper recognition of his contributions to geological knowledge, he was elected a Fellow of the Royal Society of Canada.

His wider humanities are only partially indicated by recalling that he found time in a busy professional life to be a member of the Junior Chamber of Commerce in Port Arthur where he originated and supervised a half-million dollar community center. He was also a director of the Rotary Club in that city and a member of the Masonic order.

A deserved and sincere tribute was recently paid to Clare by the Ontario minister of mines, Mr. Frost, speaking for his colleagues and fellows: his friends and associates will always remember his sincerity, vitality, warm heart, ready smile, and steady hand.

Walter Gifford Scott

An Appreciation by P. D. I. Honeyman

With the death of Walter Gifford Scott, superintendent of the Inspiration Cons. Copper Co. leaching plant, the metallurgical profession and all his associates have suffered a severe and shocking loss. Walter Scott, apparently well when he retired for the night, passed away in his sleep on Dec. 4, 1948.

Walter Scott was born on May 8, 1890,

Necrology

Date Elected	*Name*	*Date of Death*
1928	C. P. Barrett	Mar. 29, 1948
1907	George M. Colvocoresses	Dec. 14, 1948
1910	James S. Douglas	Jan. 2, 1949
1911	Charles Enzian	Dec. 7, 1948
1937	Chester H. Gibbons	Apr. 14, 1948
1917	Robert W. Handley	June 29, 1948
1886	David G. Kerr	Oct. 18, 1948
1920	Walter G. Scott	Dec. 4, 1948
1928	C. Wesley Smith	Feb. 10, 1948
1910	Frank M. Warren	Oct. 16, 1948
1944	Gordon T. Williams	Sept. 19, 1948
1908	Howard P. Zeller	Dec. 10, 1948

in Detroit, Mich. His early schooling was in Detroit, and his professional training in mining and metallurgy from the Michigan College of Mines in Houghton. Early in his career he went to work for the Anaconda Copper Mining Co. in Anaconda, Mont., where he was engaged in experimental and research work in extractive metallurgy. For a brief interlude during World War I, Scott, as assistant to the late Harold Aldrich, was loaned out to engage in the operation of a small smelting plant at Ladysmith on Vancouver Island, B. C. Following this, he returned to Anaconda and resumed his former work.

In 1918 the development of the ferric sulphate leaching process was being launched by Inspiration in Arizona. Mr. Scott joined the staff of the Company at that time and advanced steadily until he became superintendent of leaching, which position he occupied at the time of his death.

Walter Scott's name will always be associated with the successful development of this leaching process. In the early days he was foreman of the pilot plant in which the process was worked out. Following this early work he contributed greatly to the building of the commercial plant and, as assistant superintendent, guided its operation patiently and thoroughly through its early growing pains up to its present-day high state of efficiency.

In 1929, the late Harold Aldrich and Walter Scott jointly published a paper, on leaching and electrolytic precipitation of copper at Inspiration, which is a classic, constantly referred to by those interested in this phase of hydrometallurgy. In later years Walter Scott was always consulted on leaching problems, on which he was considered an outstanding authority.

Along with his accomplishments as a metallurgist, he was a good citizen, ever ready to do his part for the betterment of community life. He served several terms as president of the Cobre Valle Country Club, was a past president of the Globe Rotary Club, and also served as president of the Gila County Chamber of Commerce. He was a 32nd degree Scottish Rite Mason.

Walter Scott did his job and did it well. His death leaves a gap that will be hard to fill, but in his work he has established a foundation on which his associates can continue to build and expand the process of hydrometallurgy.

Proposed for Membership

Total AIME membership on December 31, 1948, was 15,580; in addition 4069 Student Associates were enrolled.

ADMISSIONS COMMITTEE

Albert J. Phillips, Chairman; James L. Head, Vice-Chairman; George B. Corless, T. B. Counselman, George C. Heikes, W. B. Plank, P. D. Wilson, E. M. Wise.

Institute members are urged to review this list as soon as the issue is received and immediately to wire the Secretary's office, night message collect, if objection is offered to the admission of any applicant. Details of the objection should follow by air mail. The Institute desires to extend its privileges to every person to whom it can be of service but does not desire to admit persons unless they are qualified.

In the following list C/S means change of status: R, reinstatement; M, member; J, Junior Member; A, Associate; S, Student Associate; F, Junior Foreign Affiliate.

ARIZONA

Ajo—TRAVIS, GEORGE ALBERT. (C/S—J-M). Engineer, Phelps Dodge Corp.

Bisbee—BUELL, LLOYD THOMAS. (R—M). Chief clerk, Copper Queen branch, Phelps Dodge Corp.

Douglas—FOARD, JAMES EDWIN. (J). Test engineer, Phelps Dodge Corp.

Humboldt — TOMKINSON, ELMER RAYMOND. (M). Mine superintendent, Iron King branch, Shattuck Denn Mining Corp.

Phoenix—MANNING, ROGER I. C. (R—M). Mining engineer, Arizona Dept. of Mineral Resources.

Tucson — WINTERS, VERNE WILLIAM. (M). Metallurgist, Eagle-Picher Mining and Smelting Co.

Willcox—COOPER, JOHN ROBERTS. (C/S—J-M). Geologist, U. S. Geological Survey.

ARKANSAS

Fort Smith—BOYD, BERNARD DEGEN. (R,C/S—JA-M). Vice-president and manager, Boyd Excelsior Fuel Co.

CALIFORNIA

Glendale—RHODES, JOSEPH RICHARD. (A). Vice-president and manager of refractories division, Gladding, McBean & Co.

Hammonton—HAAK, VINCENT ALFRED. (C/S—S-J). Sampler, research department, Yuba Cons. Gold Fields.

Lompoc — SCHUKNECHT, GEORGE G. (R,C/S—J-M). Superintendent of quarries and mines, Johns Manville Products Corp.

Los Angeles—DURGIN, LAURANCE IRA. (M). Geologist and petroleum engineer, self-employed. GLOVER, PATRICK NORMAN. (C/S—S-J). Exploitation engineer trainee, Shell Oil Co. HAWKINS, ROBERT RUSSELL. (M). Secondary recovery engineer, Signal Oil and Gas Co. RAY, HORATIO C. (R—M). Consulting engineer (retired).

Orinda — LINDSAY, JAMES EDWARD. (M). Reserves engineer, Standard Oil Co. of California.

Pasadena—DUWEZ, POL E. (M). Associate professor of mechanical engineering, California Institute of Technology. STOLZ, FRED C. (M). Petroleum engineer, Stanley & Stolz.

San Francisco—FARNOW, FREDERICK WILLIAM. (M). Manager, federated metals division, American Smelting and Refining Co. HEWITT, EDWARD THOMAS. (M). Manager, mining equipment division, Electric Steel Foundry Co. SELFRIDGE, JOHN SOLEY, Jr. (M). Plant superintendent, federated metals division, American Smelting and Refining Co.

COLORADO

Denver — AHLBORG, WILLIAM THOMAS. (M). Secretary, assistant to president, Denver Equipment Co. BARKER, CLAUDE L. (C/S—J-M). Assistant sales manager, E. I. du Pont de Nemours & Co. EMRICK, JOHN HOMER. (M). District manager, Joy Mfg. Co.

Idaho Springs — FAIRCHILD, GERARD LANHAM. (C/S—S-J). Geologist, American Smelting and Refining Co.

CONNECTICUT

Darien—KNAPP, THOMAS JULIAN. (A). Assistant vice-president, Freeport Sulphur Co.

Greenwich — MODEL, JEAN. (M). President and owner, Sonrisa Mining Co.

Old Greenwich—RUSSELL, JOHN C. (R,C/S—J-M). Senior process engineer, consulting engineering department, The Dorr Co.

DISTRICT OF COLUMBIA

Washington — NARTEN, PERRY FOOTE. (C/S—S-J). Geologist, U. S. Geological Survey. OLUND, HENNING EKSTROM. (R—M). Mining engineer, mining branch, Bureau of Mines.

FLORIDA

Bartow — CHILDS, WILLIAM BURTON. (M). Construction engineer, American Cyanamid Co. RAULERSON, JOHN DERIEUX, Jr. (J). Assistant mining superintendent, Florida phosphate division, International Minerals and Chemical Corp.

Pierce—ANDERSON, THOMAS JOHN, Jr. (M). Engineer, American Agricultural Chemical Co.

IDAHO

Burke—LINDSTROM, PHILIP MARTIN. (C/S—J-M). Mining engineer, Hecla Mining Co.

ILLINOIS

Glencoe—YOUNG, WILLIAM PEARCE. (R,C/S—JA-M). President, Bell & Zoller Coal and Mining Co.

Libertyville—CLAUSEN, CARL FREDERIK. (M). Manager of mfg. research, Portland Cement Assn.

Rockford—MILLER, LEE GEORGE. (M). Chief metallurgist, Greenlee Bros. & Co.

Wilmette—DICKEY, ROBERT McCULLOUGH. (R,C/S—J-M). Chief sales engineer, Bucyrus-Erie Co.

INDIANA

East Chicago—BAJOR, MENCESLAUS JOSEPH. (C/S—S-J). Metallurgical trainee, Inland Steel Co. HECHINGER, CARL JOSEPH. (C/S—S-J). Research and development metallurgist, Eagle-Picher Co.

Fort Wayne—CHEW, JOHN CARROLLTON. (C/S—S-J). Production engineer, Phelps Dodge Copper Products Corp.

Hammond—JONES, WILLIAM NORRIS. (M). Electric melter, Republic Steel Corp.

Terre Haute—MATTHEWS, MAX A. (M). President, Templeton-Matthews Corp.

KANSAS

Baxter Springs—SEXTON, KENNETH PAUL. (A). General manager, Consolidated Supply Co.

Ellinwood—MEYERS, JEAN WARREN. (J). Junior petroleum engineer, Stanolind Oil and Gas Co.

Eureka—CAWTHON, PETE W., Jr. (C/S—S-J). Trainee engineer, Phillips Petroleum Co.

Great Bend—PUGH, WILLIAM LEE. (J). Sales engineer, Lane-Wells Co.

McPherson—ZOLLER, JACQUES WILLIAM. (C/S—S-J). District exploitation engineer, Shell Oil Co.

Wichita—HOLLOW, WALTER BYRON. (M). Drilling superintendent, Bridgeport Oil Co. KOESTER, EDWARD ALBERT. (M). Consulting petroleum geologist. LUND, CARL I. (J). Sales representative, Moorlane Co. NATION, WILLIAM BENJAMIN. (R,C/S—S-M). Petroleum engineer, Co-operative Refinery Assn.

Zenith—MORGAN, JOHN VICTOR. (R,C/S—S-J). Field engineer, Stanolind Oil and Gas Co.

KENTUCKY

Jenkins—BERRY, JOHN KIRKMAN. (M). Chief production engineer, Consolidation Coal Co.

Louisville—ANDERSON, HARRY LeROY, Jr. (C/S—S-J). Ceramic engineer, Republic Steel Corp.

Wheelwright—PACE, EDWARD MINOR. (R,C/S—S-J). Engineer, Inland Steel Co.

LOUISIANA

New Orleans—KOKESH, FRANK PHILLIP. (M). Harvey district engineer, Schlumberger Well Surveying Corp.

MARYLAND

Silver Spring—LURIE, WILLIAM. (M). Metallurgist, U. S. Naval Gun Factory.

MASSACHUSETTS

Brookline—FITZPATRICK, JOHN McNEIL. (C/S—S-J). Research metallurgist, division of industrial co-operation, MIT.

Pittsfield—STONE, FRANCIS GILMAN. (C/S—J-M). Research metallurgist, Works laboratory, General Electric Co.

MICHIGAN

Detroit—GORTON, CLAIR ALLEN. (A). Metallurgical engineer, Hoskins Mfg. Co.

Marquette—DeHAAS, CLYDE TIFFANY. (A). Owner and manager, C. T. DeHaas Co. DREVDAHL, ELMER RANDOLPH. (C/S—S-J). Engineer, Vicar mine, Jones & Laughlin Ore Co.

MINNESOTA

Hibbing—STUART, JAMES REEVE. (R—M). Chief engineer, Meriden Iron Co.

Nashwauk—SWANSON, PAUL PETER. (R,C/S—A-M). Superintendent, Cleveland-Cliffs Iron Co.

MISSISSIPPI

Natchez—WHATLEY, ERROLL RENETH, Jr. (C/S—S-J). Petroleum engineer, California Co.

MISSOURI

Bonne Terre—OHLE, ERNEST LINWOOD. (C/S—J-M). Geologist, St. Joseph Lead Co.

Herculaneum—SHERMAN, JOHN WILLIAM. (R,C/S—J-M). General foreman, St. Joseph Lead Co.

Rolla—FUNK, CAMPBELL WILLIAM FLOYD. (C/S—S-J). Metallurgist, powder metallurgy section, Bureau of Mines. GORSKI, CHARLES HENRY. (M). Metallurgist, Bureau of Mines. WOODWARD, THEODORE. (J). Instructor in geology, Missouri School of Mines.

St. Louis—HAM, NEAL. (M). Branch manager, Ingersoll-Rand Co.

MONTANA

Butte—RENOUARD, EDWARD IGNATIUS, Jr. (M). Assistant general superintendent of mines, Anaconda Copper Mining Co.

NEVADA

Pioche—HYDE, DONALD EDWIN. (R,C/S—S-J). Junior engineer, Combined Metals Reduction Co.

Winnemucca—SPITZER, ROBERT BOWMAN. (M). Superintendent, Rossi mine, Merced mill, Baroid sales division, National Lead Co.

NEW JERSEY

Chatham—LIEBIG, EDWARD OTTO. (C/S—J-M). Production metallurgist, Baker & Co.

Franklin—McKECHNIE, DONALD. (M). Mill superintendent, New Jersey Zinc Co.

Morristown—ACKERMAN, DAVID HARTON. (J). Geologist, Jones & Laughlin Ore Co.

Netcong—FRANZ, HENRY WILLIAM. (C/S—J-M). Metallurgist, Singmaster & Breyer.

New Brunswick—WYATT, JAMES LUTHER. (C/S—S-J). Development engineer, titanium division, National Lead Co.

Passaic—MACIORA, JOSEPH GEORGE. (C/S—S-J). Metallurgist, Wright Aeronautical Corp.

Phillipsburg—SHEPHERD, BENJAMIN FRANKLIN. (R,C/S—A-M). Chief metallurgist, Ingersoll-Rand Co.

NEW MEXICO

Carlsbad—NELSON, RICHARD BENTON. (J). Junior mine engineer, Potash Co. of America.

Silver City—WALTON, MARSHALL RHODES. (M). President, M. R. Walton & Associates.

Vanadium—NEUMAN, JAMES VINCENT, Jr. (C/S—J-M). Assistant to manager, Bayard department, U. S. Smelting Refining and Mining Co.

NEW YORK

Brookhaven—COOK, HARRY CLARE. (J). Associate engineer, Brookhaven National Laboratories.

Brooklyn—BUGLIONE, VINCENT JOSEPH. (R,C/S—S-J). Metallurgist P-1, N. Y. Naval Shipyard. ROSS, EARL WARREN. (R,C/S—S-J). Metallurgist, N. Y. Naval Shipyard. YOKELSON, MARSHALL VICTOR. (M). Research metallurgist, General Cable Corp.

Flushing—NININGER, ROBERT D. (R,C/S—S-J). Geologist, assistant to the manager, raw materials operations, Atomic Energy Commission.

New York—DeKANSKI, LEON M. (R—M). Project engineer, The Dorr Co. MECHELYNCK, ANDRE L. (C/S—S-J). Trainee, American Radiator and Standard Sanitary Co. WEIDNER, PAUL NELSON. (M). Petroleum engineer, Standard Oil Co. (New Jersey).

New York Mills—WILLIAMS, GRIFFITH, Jr. (M). Supervisor of methods, Revere Copper and Brass Co.

Syracuse—CHUTE, NEWTON EARL. (M). Assistant professor of geology, Syracuse University.

OHIO

Cleveland—BURGESS, CHARLES OWEN. (R,C/S—JA-M). Technical director, Gray Iron Founders' Society. WILBUR, JOHN SMITH. (A). Sales representative, Cleveland-Cliffs Iron Co.

Gates Mills—POTTER, HORACE W. (C/S—J-M). Consultant (steel), Arthur G. McKee & Co.

Steubenville—McCABE, CHARLES GRIFFITH. (M). Foreman of openhearth metallurgy, Wheeling Steel Co.

OKLAHOMA

Bartlesville—CARPENTER, ANDREW HOWLAND. (C/S—S-J). Junior engineer, Cities Service Oil Co. SMITH, SHOFNER. (J). Senior Reservoir engineer, Phillips Petroleum Co.

Oklahoma City—SEELY, DWIGHT H., Jr. (J). Junior process engineer, Sohio Petroleum Co. SNEED, ROBERT WHITE. (M). District sales manager, Eastman Oil Well Surveying Co.

Okmulgee—NEWMAN, ROBERT CLARK. (C/S—S-J). Petroleum engineer, Thomas S. Newman, Geologist and Civil Engineer.

Stillwater—SCHLEMMER, ALFRED EUGENE. (J). Instructor in mechanical engineering, Oklahoma Agricultural and Mechanical College.

Tulsa—BAUMAN, WILLARD EDWIN. (J). Production engineer, Gulf Oil Co. JARRELL, L. C. (C/S—S-J). Petroleum engineer trainee, The Texas Co. OCHELTREE, TEMPEST MATTHEWS. (R,C/S—S-M). Chief engineer, Devonian Co. WILDER, LAWRENCE BERNARD. (J). Junior research engineer, Stanolind Oil and Gas Co.

Webb City—DENNY, JACK PERSHING. (J). Engineer, Phillips Petroleum Co.

OREGON

Hillsboro—McWILLIAMS, JACK HUGH. (M). Geologist, Alcoa Mining Co.

PENNSYLVANIA

Beaver Falls—SUMMERFIELD, CHRISTIAN JOHN. (M). Research associate, Mellon Institute.

Bethlehem—SELLERS, PAUL EDWARD. (M). Quarry superintendent, Bethlehem Steel Co.

Exton—VON STROH, GERALD F. H. (M). Director, mining development program, Bituminous Coal Research.

Feasterville—SCHUCH, EDWARD ANTHONY. (M). Chief engineer, Aero Service Corp.

McKeesport—KELLER, RICHARD LATCHFORD. (M). Fellow, Mellon Institute.

Philadelphia—HESS, GEORGE L. (M). Sales engineer, Aero Service Corp.

Uniontown—HAMILTON, JAMES L. (M). Manager, safety and operating departments, Republic Steel Corp.

SOUTH DAKOTA

Belle Fourche—MIDDLETON, DAVID MAXWELL. (C/S—J-M). Plant superintendent, Aladdin Wyoming plant, National Lead Co.

Lead—WARREN, LYLE GEORGE. (M). Structural design, Homestake Mining Co.

TEXAS

Alice—BARB, GLEN WAYNE. (J). Petroleum engineer, Magnolia Petroleum Co.

Austin—CLARK, GLYNN ALDEN. (C/S—S-J). Research fellow, Texas petroleum research committee, University of Texas. PLAZ, LUIS. (M). Petroleum inspector, Venezuelan Government.

Beaumont—DUBLIN, JAMES ROLAND. (C/S—S-J). Junior petroleum engineer, Humble Oil and Refining Co.

Borger—DANA, PHILIP LYMAN. (M). Geologist, J. M. Huber Corp.

Dallas—BOCK, MORRIS. (M). Chief chemist, Southwest division, Sun Oil Co. LIPSON, LEONARD B. (J). Senior physicist, field research laboratories, Magnolia Petroleum Co. RENFRO, HAROLD BELL. (M). Geologist and petroleum engineer, Stodel Oil Co. SMITH, GERALD LLOYD. (J). Petroleum engineer, Magnolia Petroleum Co. STORMONT, DAVID HENRY. (M). District editor, *The Oil and Gas Journal.*

El Paso—DEISLER, PAUL F. (C/S—A-M). Management consultant, self-employed.

Fort Worth—WILSEY, LAWRENCE EARL. (C/S—S-J). Junior petroleum engineer, Stanolind Oil and Gas Co.

Freer—MURPHY, GORDON JOSEPH WARNER. (J). Petroleum field engineer, The Texas Co.

Houston—BEEZLEY, JOEL E. (C/S—S-J). Production engineer, Pure Oil Co. BEILHARZ, CARL FRICHOT. (M). Division reservoir engineer, Pure Oil Co. BERNHARD, WILLIAM E. (M). Petroleum engineer, Ginther, Warren & Ginther. GUEST, HENRY GRADY. (M). Senior engineer, Schlumberger Well Surveying Corp. LEGERON, ROBER AIME. (M). Manager of field operations, Schlumberger Well Surveying Corp. POYNER, HERBERT FLAKE, Jr. (C/S—S-J). Graduate student, University of Texas. SELIG, AUGUST LEWIS. (M). Consulting geologist.

McAllen—RIDGWAY, ROBERT JOSEPH. (C/S—S-M). Petroleum engineer, Sun Oil Co.

Midland—LITTLE, WILLIAM NORMAND. (M). Division engineer, Tide Water Associated Oil Co. MINTZ, JOHN MOORE. (J). Associate engineer, Tide Water Associated Oil Co.

Wichita Falls—REYNOLDS, JOHN CLIFFORD STANLEY. (C/S—S-J). Research assistant, department of petroleum engineering, University of Texas.

UTAH

Bingham Canyon—BARLOW, VINAL STOKER. (M). General mine foreman, Kennecott Copper Corp. McNEILIS, THOMAS ROSS. (M). Electrical foreman, Utah copper division, Kennecott Copper Corp. WILLEY, RICHARD HAVEN. (R,C/S—S-M). Assistant general drill and blast foreman, Utah copper division, Kennecott Copper Corp.

Lark—COFFEY, JAMES ARTHUR. (A). Chief clerk, Lark mine, U. S. Smelting Refining and Mining Co.

Salt Lake City—EARLY, LAWRENCE WILLIAM. (M). Sales service representative, Hercules Powder Co. RICHARD, FRED VINCENT. (M). Safety engineer, American Smelting and Refining Co.

VIRGINIA

Arlington—BRANDENBURGER, OSCAR LOUIS. (R—A). Chief, materials supply, Civil Aeronautics Administration.

WASHINGTON

Richland—CALLEN, ALFRED COPELAND, Jr. (J). Metallurgist, Hanford works, General Electric Co.

Seattle—STRANDBERG, THEODORE R. (A). Mining engineer, Strandberg & Sons.

Vancouver—JENSEN, JAMES HENRY. (M). Plant and chemical engineer, Pacific Carbide and Alloys.

WISCONSIN

Milwaukee—MAROLD, FRANK. (R,C/S—S-J). Application engineer, export sales department, Allis-Chalmers Mfg. Co.

WYOMING

Casper—ROBBINS, RAYMOND WILLIS. (M). District geologist, The Texas Co.

Cody—HAMMAR, HAROLD DAVID. (J). Junior petroleum engineer, Stanolind Oil and Gas Co. POLLOCK, CHARLES BERTRAND. (J). Junior petroleum engineer, Stanolind Oil and Gas Co.

Lusk—GALLIVAN, JOHN C. (C/S—J-M). Rocky Mountain division superintendent, Wood River Oil and Refining Co.

MANITOBA

Flin Flon—HUNT, EDWIN S. W. (M). Assistant mine superintendent and chief mining engineer, Hudson Bay Mining and Smelting Co.

ONTARIO

Ottawa—IGNATIEFF, ALEXIS. (M). Mining engineer, division of fuels, Bureau of Mines.

Toronto—DEAN, WILLIAM JOHN. (M). Manager, Kennex, Ltd.

ARGENTINA

Jujuy—RICCI, LUCIANO. (M). Chemical laboratory chief, Institute de Geologia y Mineria de la Universidad Nacional de Tucumun.

VENEZUELA

Caracas—STILLWELL, KENNETH LAWRENCE, Jr. (J). Trainee, The Texas Co. WILLIAMS, DAVID BOWEN. (M). Chief scout, Shell Caribbean Petroleum Co.

ENGLAND

London—LANCE, ALFRED EMERSON. (R—M). Principal control officer, ores and minerals, Germany section, British Foreign Office.

LIBERIA

Monrovia—REILINGH, ALBERT. (J). Geologist, Liberia Mining Co.

FEDERATED MALAY STATES

Perak—KENNEDY, ERROL MOSTYN. (C/S—S-J). Junior assistant, Gopeng Cons. Ltd.

INDIA

Bombay—MEHTA, PESI EDI. (C/S—S-M). Technical assistant, Tata Industries, Ltd.

Oorgaum—DAVID, JOSEPH PETER. (M). Inspector of mines, department of mines and explosives, Government of Mysore.

NEW SOUTH WALES

Broken Hill—FISHER, GEORGE READ. (R—M). General manager, Zinc Corp.

NEW CALEDONIA

Noumea—ROUTHIER, PIERRE JEAN. (M). Chief of the geological mission, Office de la Recherche Scientifique Coloniale.

Student Associates

Elected December 15, 1948

Thomas M. Anderson........Univ. Ariz.
George H. Bailey..........Univ. Idaho
James H. Barnett....Colo. Sch. Mines
Lawrence E. Barrett..Colo. Sch. Mines
Boris J. Bermes......Colo. Sch. Mines
Hubert E. Berninghausen
Colo. Sch. Mines
Billie L. Bessinger...Colo. Sch. Mines
Ervin G. Bilderback........Texas A&M
Robert R. Blair...........Okla. A&M
John L. Bolles........Colo. Sch. Mines
Ollen N. Bradford.........Okla. A&M
Tyler Brinker.........Colo. Sch. Mines
Richard S. Bryson....Colo. Sch. Mines
Floyd D. Burnside...Colo. Sch. Mines
David L. Caldwell.....Colo. Sch. Mines
John W. Caldwell.....Colo. Sch. Mines
Walter M. Chapman..Colo. Sch. Mines
Chih Wen Chen.........Ill. Inst. Tech.
David C. Childers....Colo. Sch. Mines
Ben B. Chomick.......Colo. Sch. Mines
Charles C. Coenen....Colo. Sch. Mines
Robert H. Coleman.........Okla. A&M
Alva G. Comer............Okla. A&M
Daniel M. Cooper......Colo. Sch. Mines
William M. Denton.........Okla. A&M
William P. Donovan....Ill. Inst. Tech.
Joseph R. Driear.......Colo. Sch. Mines
Wilfried Drolet, Jr.........Univ. Ariz.
Joseph C. DuBois, Jr....Colo. Sch. Mines
Richard J. Durning....Colo. Sch. Mines
Arthur J. Dyson......Colo. Sch. Mines
Aly A. El-Gazzar...........Okla. A&M
Burnett E. Ellis.............Univ. Mo.
Foster E. Endacott...Colo. Sch. Mines
Richard K. Epps............Texas A&M
Hugh W. Evans.......Colo. Sch. Mines
Ernest C. Fitch, Jr..........Okla. A&M
Handren K. Fitzgibbons
Colo. Sch. Mines
Walter S. Forbes.....Colo. Sch. Mines
Martin S. French.....Colo. Sch. Mines
Richard H. Fulton....Colo. Sch. Mines
Jeremy V. Gluck.............Univ. Mich.
Dennis E. Gregg......Colo. Sch. Mines
Niles E. Grosvenor...Colo. Sch. Mines
Alexander F. Halcrow.Colo. Sch. Mines
Harley H. Hartman....Colo. Sch. Mines
James S. Hastings....Colo. Sch. Mines
John A. Heffelfinger..........Okla. A&M
Robert N. Hendry.....Colo. Sch. Mines
Donald C. Herron.....Colo. Sch. Mines
J. D. Hicks.................Okla. A&M
John C. Holden..............Okla. A&M
William R. Holman.........Univ. Calif.
Joseph P. Hopkins...........Okla. A&M
William E. Hopkins..........Univ. Mich.
Kenneth W Hottinger.Colo. Sch. Mines
Donald L. Hovorka.....Colo. Sch. Mines
Wei-pei Hu..................Univ. Utah
Shao-Chi Huang.........Ill. Inst. Tech.
Douglas O. Hukkanen........Univ. Calif.
John B. Hundley, Jr....Stanford Univ.
John G. Jaka..........Colo. Sch. Mines
John F. Jarrell...............Queen's Univ.
Glen O. John...............Adelaide Univ.
Thomas C. Keating.....Colo. Sch. Mines
Norman Korn ....Colo. Sch. Mines
Kenneth B. Larson....Colo. Sch. Mines
William A. Libby..Texas Mines & Met.
David R. Lohr........Colo. Sch. Mines
Murrell D. Long.......Colo. Sch. Mines
David M. Mathews....Colo. Sch. Mines
William W. May.........Colo. Sch. Mines
Robert C. McCain.....Colo. Sch. Mines
Sidney J. McDuff..........Univ. Ariz.
Ira E. McKeever, Jr....Colo. Sch. Mines
Donald T. Moore......Colo. Sch. Mines
Edward A. Morrison...Colo. Sch. Mines
Robert H. Muench....Colo. Sch. Mines
Roger R. Nelson.......Colo. Sch. Mines
John D. Noll.........Colo. Sch. Mines
Hugh W. Olmstead....Colo. Sch. Mines
Homer C. Osborne..........Texas A&M
Harold B. Overstreet..Colo. Sch. Mines
Robert S. Padboy......Colo. Sch. Mines
William L. Parker....Colo. Sch. Mines
Herbert L. Peel...........Okla. A&M
Eugene M. Pohoriles........Okla. A&M
Fred F. Polizzano....Bklyn. Poly. Inst.
Dale A. Reagan.............Okla. A&M
Joseph C. Richardson, Jr...Texas A&M
Harold J. Riggott.....Colo. Sch. Mines
James A. Robertson........Okla. A&M
Clovis E. Rodelander.......Okla. A&M
Charles W. Rohler....Colo. Sch. Mines
David A. Rowland....Colo. Sch. Mines
Leonard B. Saltzman....Ill. Inst. Tech.
Lawrence Sama.......Bklyn. Poly. Inst.
Norman Schapiro............Bklyn. Coll.
Treadwell C. Schmitt.Texas Mines&Met.
Darrell G. Shurtliff....Colo. Sch. Mines
Richard C. Siegfried..Colo. Sch. Mines
John W. Stephens......Colo. Sch. Mines
Harold W. Stouffer....Colo. Sch. Mines
Paul P. Sundback (C/S—J-S)....MIT
Roger W. Swindle...........Univ. Wis.
William P. Thornton.........Okla. A&M
Larry Toman, Jr.....Colo. Sch. Mines
Henry C. Wachtman, Jr....Okla. A&M
Arthur W. Wadman, Jr..Colo. Sch. Mines
James W. W. Walker....Stanford Univ.
Ralph Ward, Jr............Okla. A&M
James W. Warfield....Colo. Sch. Mines
Jasper N. Warren....Colo. Sch. Mines
John R. Weeks, IV....Colo. Sch. Mines
Robert O. Wenzel..........Univ. Ariz.
John R. Weyler......Colo. Sch. Mines
Robert D. Whitmer..Mo. Mines & Met.
Edward H. Whitlock......Univ. Okla.
David B. Wilkie, Jr......Kansas Univ.
Kimball M. Williams...Colo. Sch. Mines
Claud V. Winter................CCNY
Russell L. Wood......Colo. Sch. Mines
Shui Choh Yue.........Ill. Inst. Tech.

Elected January 19, 1949

Charles J. Adams....Mont. Sch. Mines
William E. Adkins..N. Mex. Sch. Mines
Richard A. Alexander
Mich. Min. & Tech.
Robert B. Anders....Mo. Mines & Met.
George M. Anderson..Mo. Mines & Met.
Richard C. Anderson (R—S)
N. Mex. Sch. Mines
Frank M. Antonioli..Mont. Sch. Mines
Charles Arentzen....Mont. Sch. Mines
John D. Aumen, Jr...N. Mex. Sch. Mines
John W. Bader (R—S)...Lehigh Univ.
Stephen S. Badzik....Univ. Pittsburgh
Walter E. Baily.....Mo. Mines & Met.
Emmett B. Ball, Jr.........Univ. Nev.
Dale G. Ballmer....N. Mex. Sch. Mines
Leo G. Barbee.............Okla. A&M
E. Crittenden Barker.......Univ. Ala.
Claude R. Barnes, Jr..Mont. Sch. Mines
John S. Benko.........Lafayette Coll.
Robert W. Berkhahn..Mich. Min. & Tech.
Irving G. Betz......Mo. Mines & Met.
James R. Boyle.......Mo. Mines & Met.
George F. Braun.......Lafayette Coll.
Harold J. Braun...Mich. Min. & Tech.
Richard M. Brazier......Univ. S. Calif.
Jack Brodsky......N. Mex. Sch. Mines
Robert L. Bronnes..........Univ. Ala.
George G. Brown......Univ. S. Calif.
Willow M. Burand..N. Mex. Sch. Mines
Henry J. Burnell.......Lafayette Coll.
Russell A. Calvin, II....Lafayette Coll.
Elton F. Carlile, Jr.........Univ. Nev.
Andrew T. Cassell, Jr.......Univ. Calif.
James H. Clement....Mont. Sch. Mines
Elbert E. Comstock..Mo. Mines & Met.
Birney S. Covell, Jr.......Univ. Wash.
Bill J. Cox...............Okla. A&M
William E. Coolbraugh.Mo. Mines&Met.
Richard G. Craddock
N. Mex. Sch. Mines
Worth B. Cunningham, Jr.
Rutgers Univ.
David Dalpini.......Mo. Mines & Met.
Gordon P. Daniells..N. Mex. Sch. Mines
Prodyot K. Das......Mont. Sch. Mines
Donald H. Delbert..N. Mex. Sch. Mines
John P. Denny (R—S)....Univ. Utah
Buddy R. Dixon...........Okla. A&M
James J. Doherty..N. Mex. Sch. Mines
William L. Donovan..N. Mex. Sch. Mines
Richard R. Douglas..Mont. Sch. Mines
John T. Eastlick......Mont. Sch. Mines
Thomas D. Edsall, III....Rutgers Univ.
Paul K. Edwards....Mo. Mines & Met.
Lewis B. Eubanks.........Univ. Ala.
Elwood Eutermoser.N. Mex. Sch. Mines
Robert E. Evenson...Mont. Sch. Mines
John A. Feeger.............Univ. Nev.
Robert J. Ferranti..N. Mex. Sch. Mines
Charles W. Fleming..N. Mex. Sch. Mines
Crawford E. Fritts..Mich. Min. & Tech.
Bill L. Gabelmann...Mo. Mines & Met.
Robert J. Ganley....Mo. Mines & Met.
John E. Gardner, Jr...Mo. Mines & Met.
Jack T. Gentry......Mont. Sch. Mines.
Gustaf M. Granstrom......Univ. Nev.
James O. Greenslade
Mich. Min. & Tech.
Darwin E. Gregory..N. Mex. Sch. Mines
John D. Grimsley..N. Mex. Sch. Mines
Robert O. Haas......Univ. Pittsburgh
Robert J. Hand..........Texas A&M
Bobby J. Harrell..........Texas A&M
James V. Hastings..........Univ. Ala.
Kenneth G. Hatfield..Mich. Min. & Tech.
John F. Hildebrand, Jr...........RPI
William E. Hill......Mo. Mines & Met.
Melvin C. Hockenbury
Mo. Mines & Met.
James S. Hopkins, Jr.
Mo. Mines & Met.
John E. Hopper....N. Mex. Sch. Mines
Arthur A. Huntsinger....Rutgers Univ.
Gordon B. Irvine, Jr.......Wash. State
Robert K. James.........Univ. S. Calif.
Sydney W. Jarvis........Otago Univ.
Paul E. Jones......Mich. Min. & Tech.
Vishwanath J. Joshi..Mont. Sch. Mines
James E. Kapteina..N. Mex. Sch. Mines
Allen D. Kennedy....Mont. Sch. Mines
Dale F. Kittel.......Mont. Sch. Mines
Max E. Kliewer..........Univ. Kans.
Albert M. Krainess..Mo. Mines & Met.
John A. Kruppenbach
N. Mex. Sch. Mines
Arthur W. Kruse, Jr...Univ. S. Calif.
Donald A. Lammers......Univ. Calif.
Richard J. J. Lampson.....Univ. Wash.
John R. Land..............Okla. A&M
Louis L. Landers......Colo. Sch. Mines
Frederic G. Layman....Lafayette Coll.
Donald W. Levandowski
Mont. Sch. Mines
Wallace C. Love......Mont. Sch. Mines
James L. MacFarlane.....Texas A&M
Jack M. Mackenzie.......Univ. S. Calif.
Richard F. Marvin....Mont. Sch. Mines
Stewart H. McGaw.......Univ. Calif.
Paul McIlroy, Jr.....Mo. Mines & Met.
Jack E. McMahan....Mo. Mines & Met.
John S. McNabb, Jr.
Mich. Min. & Tech.
Russell H. Michel.......Rutgers Univ.
James T. Mikkola....Mont. Sch. Mines
Robert J. Misbeek......Univ. S. Calif.
Charles E. Morgenthaler...Texas A&M
Walter A. Mourant......Rutgers Univ.
Paul H. Nikoloff.......Rutgers Univ.
Daniel T. O'Brian...Mich. Min. & Tech.
John H. Osborne, Jr...Mo. Mines & Met.
Bobbie L. Perry.....Mo. Mines & Met.
Robert D. Perry.............Ohio State
Charles W. Phillips (R—S).Univ. Mich.
Salvatore F. Piperato....Lafayette Coll.
William L. Polglase..Mont. Sch. Mines
William R. Prindle........Univ. Calif.
Robert W. Pullen....Mont. Sch. Mines
William E. Remmert..Mo. Mines & Met.
Linus J. Renner......Mo. Mines & Met.
Earl W. Rogers (R—S)...Texas A&M
Harold B. Russell..N. Mex. Sch. Mines
John P. Russell........Lafayette Coll.
Ronald E. Samples..N. Mex. Sch. Mines
Joseph A. Saplis....Mich. Min. & Tech.
Seymour O. Schlanger....Rutgers Univ.
Vernon B. Schneider.....Univ. Toronto
Eugene T. Schnieder..Mo. Mines & Met.
James B. Scott............Univ. Nev.
Paul D. See..........Oreg. State Coll.
John W. Shannon.........Okla. A&M
Wright C. Sheldon..Mich. Min. & Tech.
Thomas A. Simpson ..Mo. Mines & Met.
Richard W. Sippel..N. Mex. Sch. Mines
James E. Slosson.......Univ. S. Calif.
Donald R. K. Smith......Otago Univ.
Harrison L. Staub.....Univ. S. Calif.
Paul M. Stevens....N. Mex. Sch. Mines
Lawrence H. Tate..N. Mex. Sch. Mines
Edwin M. Thomasson..Mo. Mines & Met.
Thomas E. Tietz..........Univ. Calif.
Joseph W. Tripp....Mont. Sch. Mines
Robert E. Turman....Mo. Mines & Met.
Dominic A. Verive...Mo. Mines & Met.
Albert Villarreal...Mich. Min. & Tech.
John W. Warren, Jr...Mont. Sch. Mines
William E. Watt......Lafayette Coll.
Ronald J. White......Mont. Sch. Mines
Robert W. Wilks....Mo. Mines & Met.
Richard V. Wyman........Univ. Mich.
Francis M. Young....Mont. Sch. Mines
James R. Young, Jr..Mich. Min. & Tech.

Application of Screening and Classification for Improved Fine Anthracite Recovery

By W. J. PARTON,* Member AIME

The efficient recovery and preparation of small sizes of anthracite called No. 4 Buckwheat (3/32 by 1/32 in.) and No. 5 Buckwheat (1/32 in. by 0), present a difficult problem to the anthracite operators. In many instances preparation of these sizes, particularly No. 5 anthracite, is extremely inefficient. In many of the older preparation plants, inadequate facilities, and often none at all, were provided as an integral part of the plant for cleaning this fine anthracite. Consequently, much of the material smaller than 3/32 in. was discarded. As the demand for these sizes increased, facilities for preparing the fine sizes were often crowded into existing structures with consequent sacrifices of capacities and efficiency. In addition to this condition, the methods of preparing the finest sizes are being developed in an attempt to improve their efficiencies. Because the demand for small sizes of anthracite still is increasing, many operators would benefit by investigating and improving the cleaning equipment employed on these sizes.

The object of this paper is to describe a stationary screen device from which the underflow is restricted by orifices, called a launder screen, along with operating results of several applications of this screen; a settling tank in which two classified products are produced by the installation of a cylindrical partition of smaller diameter than the original tank, one product being recovered from the small tank created by the partition and one product from the space between the inner and outer tank walls; a small pocket classifier or hydraulic trap for use in removing high ash particles from a sludge flow; the classification or segregation of sludge solids occurring in a 16 in. diam pipe flow by analysis of samples procured at different zones; and the operating results of a Fahrenwald sizer, as well as the performance of the concentrating tables handling the classified products.

San Francisco Meeting, February 1949.

TP 2532 F. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before April 30, 1949. Manuscript received Sept. 22, 1948; revision received Nov. 15, 1948.

* Assistant to the General Manager, Lehigh Navigation Coal Co., Lansford, Pa.

These simple devices were employed at the collieries of the Lehigh Navigation Coal Company Incorporated, Lansford, Pa., in order to improve preparation results on the fine sizes of anthracite.

Launder Screens

The launder screen is a screening and dewatering device which probably could be used advantageously in the flow diagram of many fine coal plants. Fig 1 shows that it consists of a stationary screen constructed by placing 6 in. high partitions every 6 in. along a launder. Holes are then drilled on 6-in. centers across the bottom of the launder to receive pipe bushings of the desired diameter. The screen cloth is tacked on top of the partitions.

When water and solids are fed to the screen, only a small portion of the total water is removed through the orifices in each compartment so that the water in the feed is distributed evenly over the whole length of the screen. The screening action which results is very efficient because the solids are kept in a fluid condition for the full length of the screen. Blinding of the screen can be minimized by the use of screen cloth

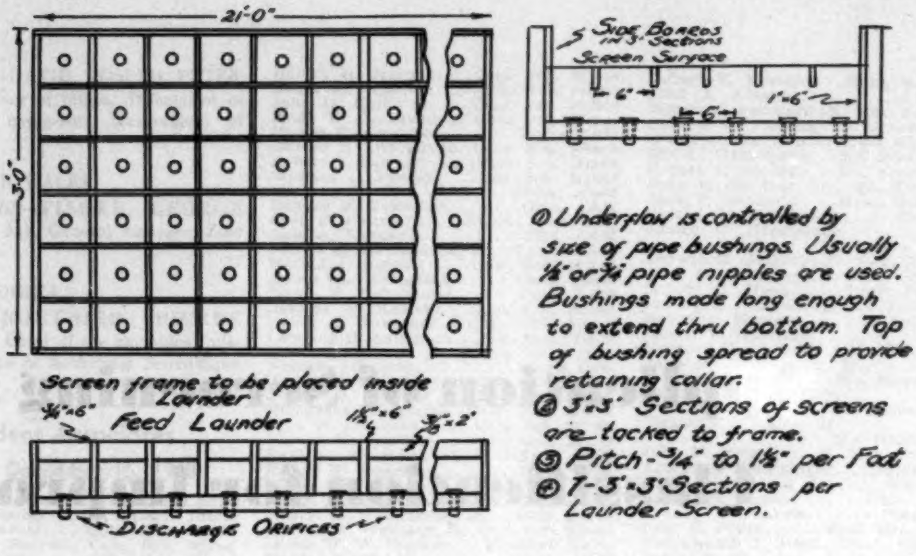


FIG 1—Launder screen.

Table 1 . . . Operating Results of Original No. 5 Anthrafine Plant, Nesquehoning Colliery

Sample Number	1		2		3		4	
	Feed		Refuse from No. 5 Cleaner		Underflow Dewatering Screen		Coal Product	
Tons Per Hour	60		9.4		45.1		5.5	
Ash, Per Cent	36.06		65.5		32.7		13.79	
Size Analysis	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent
+8 mesh	0.00		0.32	53.6	0.00		0.20	8.3
+10	0.88	23.42	2.40		0.20	10.05	5.00	
+14	2.40	14.7	8.28	50.9	1.64		20.32	8.7
+20	26.56	29.0	35.16	62.1	17.60	14.1	39.48	11.7
+28	25.48	32.8	26.36	64.7	22.92	22.0	20.36	16.1
+35	18.80	39.9	15.56	69.6	20.92	34.3	9.60	25.6
+48	10.92	46.7	7.00	70.5	13.72	45.1	3.28	29.5
+65	6.12	60.4	2.96	75.7	8.52	56.0	1.20	34.2
+100	4.20	60.4	1.36	76.1	6.36	59.5	0.40	
+150	1.68	57.3	0.08		2.64	59.6	0.08	33.9
+200	1.08	52.5	0.40	63.8	1.80	54.0	0.04	
−200	1.88	51.5	0.12		3.68	56.0	0.04	
	100.00		100.00		100.00		100.00	

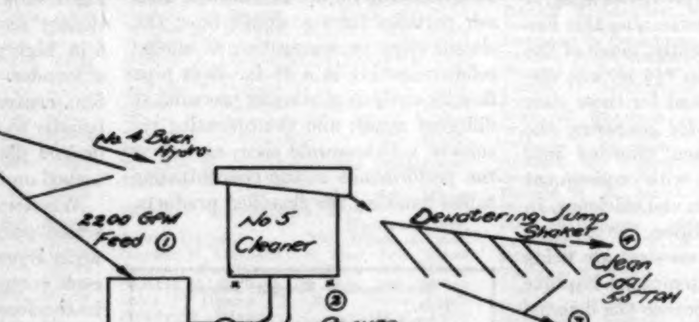


FIG 2—Original No. 5 anthrafine cleaning system, Nesquehoning Breaker.

Table 2 . . . Operating Results of Revised No. 5 Anthrafine Plant, Nesquehoning Colliery

Sample Number	1		2		3		4		5		6		7	
	Feed to Stationary Screen		Underflow or Stationary Screen		Overflow of Screen Feed to Cleaner		Cleaner Refuse		Underflow of 6 by 6 Ft Stationary Screen (Coal End)		Underflow Dewatering Screen		Coal Product	
Tons Per Hour	61		10		51		10		2.4		8.8		29.8	
Ash, Per Cent	39.0		52.83		34.18		71.83		48.55		46.43		14.74	
Gallons Per Minute	2,300		1,200		1,100				500		600			
Size Analysis	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent
+10 mesh	0.2	19.9	0.0		0.9	23.7	2.1	37.1			0.1		0.2	
+14	0.9		0.1	33.0	3.2	11.5	4.8	43.5			0.1	19.54	3.0	7.8
+20	12.5	21.5	1.4		24.7	29.2	35.4	71.5			1.3		22.2	11.2
+28	18.5	20.7	2.0	35.3	25.8	27.1	29.1	74.2	0.2	31.4	4.0	19.23	40.92	11.8
+35	20.8	24.2	7.5	39.0	21.0	32.4	18.9	74.0	7.2		18.2	31.2	24.92	19.8
+48	15.0	32.6	16.5	47.9	11.4	38.2	6.3	72.9	23.4	41.5	22.5	47.1	6.80	41.8
+65	10.4	47.5	20.4	53.1	5.6	52.3	2.0	71.4	24.4	48.1	16.7	57.6	1.60	44.1
+100	8.5	57.3	20.9	57.8	3.1	50.7	0.9	71.1	20.9	54.8	13.5	56.8	0.20	
+150	4.4	58.1	10.7	60.7	1.3	56.7	0.2		9.4	57.4	7.2	56.0	0.08	
+200	3.3	59.0	6.0	58.5	0.8	54.1	9.1	66.7	4.7	55.8	4.5	54.6	0.04	41.6
−200	5.5	60.6	14.5	60.7	2.2	60.5	0.2		9.8	54.5	11.9	60.9	0.04	
Solids, per cent	7.92		3.33		17.4				1.92		4.36			

Note (samples 1–2): 3 ft of 24 mesh; 15 ft of 20 mesh

Note (samples 5–6): 18 ft of 24 mesh

with approximately 50 pct, or more, open area and by the use of the proper orifices in the bottom of the trough. Large orifices cause more blinding of the screen.

Applications of this type screen are varied; it can be employed to remove excess water from a feed product ahead of cleaning equipment, as a screen to remove fine particles high in ash content from a sludge, or to produce a sized product. Examples of where it has been employed successfully are as follows:

Nesquehoning Breaker fine coal plant for No. 5 Buckwheat (1/32 in. by 0) was extremely inefficient because of the inadequacy of the hydraulic classifier type machine to handle the high ash feed. This classifier called a gyrotator is similar to a hydrotator except that the water is pumped through a stationary casting in the bottom of the tank. The casting is designed to impart a tangential flow to the water. Most of the product from the classifier was wasted in an effort to get a small tonnage to market at a satisfactory ash content. Fig 2 shows the flow diagram of the cleaning system previous to alterations and Table 1 gives the operating data.

In order to improve the efficiency of

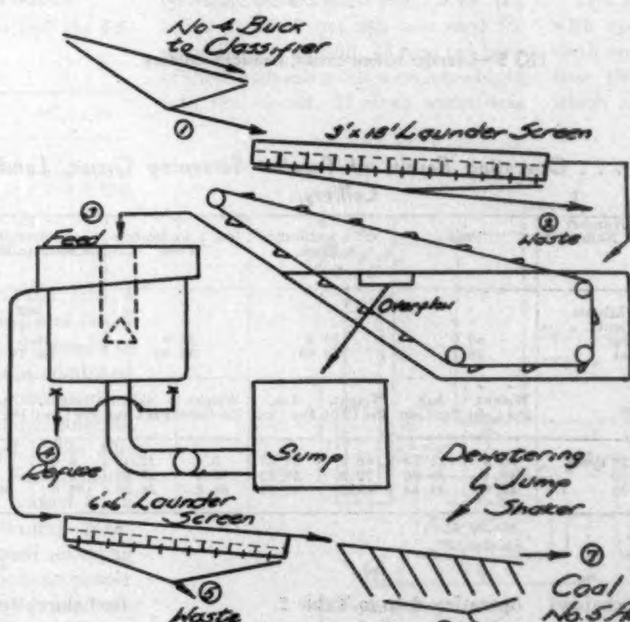


FIG 3—Revised No. 5 anthrafine cleaning system, Nesquehoning Breaker.

FIG 4—Installation of launder screens, Lansford Colliery.

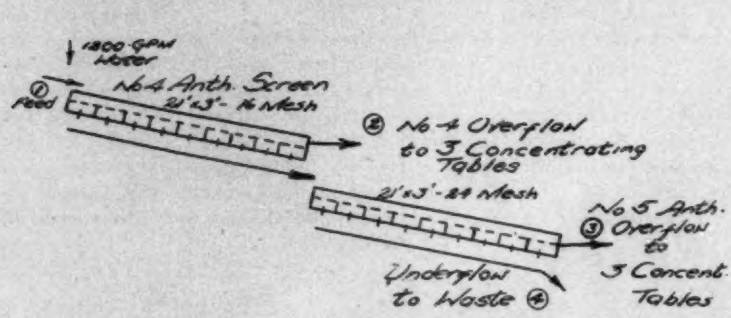


FIG 5—Launder screen circuit, Lansford Colliery.

Table 3 . . . Operating Results of Parallel Screening Circuit, Lansford Colliery

Sample Number Product Name	1 Feed		2 No. 4 Anthrafine Feed		3 No. 5 Anthrafine Feed		4 Underflow 24 Mesh to Waste	
Gallons Per Minute							900	
Solids, Per Cent							7.17	
Tons Per Hour	60.0		29.8		32.0		16.2	
Ash, Per Cent	28.18		28.68		34.09		46.79	
Size Analysis	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent
+20 mesh	35.8	21.68	66.0	27.57	0.6	22.33	0.0	0
+30	19.4	23.66	20.8	29.23	18.6	29.11	0.0	0
−30	44.8	35.34	13.2	33.05	80.8	36.20	100.0	46.7

the cleaning system several changes were made by employing launder screens and a dewatering tank. The revised circuit is shown on Fig 3, and operating data in Table 2.

In this particular cleaning circuit the launder screen enabled 1200 gpm of excess water to be eliminated in the feed slurry and the removal of 10 tons per hour (tph) of high ash material from the circuit ahead of the cleaner. The second launder screen installed on

Table 4 . . . Operating Results, Lansford Launder Screen

Retained On	Feed to 16 Mesh Screen: Elevator Solids, Per Cent	Feed to 16 Mesh Screen: Dilution Water Solids	Oversize No. 4 Feed 16 Mesh Screen, Per Cent	Undersize 16 Mesh Screen, Per Cent	Oversize No. 5 Feed 20 and 24 Mesh Screens, Per Cent	Undersize to Waste 20 and 24 Mesh Screens, Per Cent
+8 mesh	0.08	0.0	0.20	0.00	0.00	0.00
+10	8.92	0.0	16.88	0.00	0.00	0.00
+14	6.48	0.0	16.40	0.00	0.00	0.00
+20	25.48	0.0	42.20	1.20	2.00	0.10
+28	18.80	0.0	15.08	16.00	29.36	2.30
+35	15.52	0.6	3.52	20.80	36.16	6.70
+48	9.72	0.8	1.08	14.20	14.68	11.50
+65	5.80	3.6	0.60	8.80	5.52	12.50
+100	1.20	10.8	0.40	6.50	2.68	5.00
+150	4.60	8.8	0.68	7.20	2.00	17.90
+200	1.40	8.0	0.68	5.50	1.48	7.60
−200	2.00	67.4	2.28	19.80	6.04	36.40
Total	100.0	100.0	100.0	100.0	100.0	100.0
Composite, ash	24.75	42.81	22.06	34.26	24.03	38.91
Solids, per cent		5.83			32.11	8.84
Flow, gpm		1200.			300.	1030.
Tons per hour	60.0	17.5	30.5	47.0	24.2	22.8
Recovery, per cent	100		39.4	60.6	31.2	29.4

the coal product from the classifier served to eliminate approximately 500 gpm of water which the original dewatering shaker was not capable of handling because of the increased bed on this screen resulting from increased recovery. Also this screen assisted in removing the high ash fines, which were overflowed by the classifier as indicated by the analysis of the solids.

Modification of this anthrafine circuit resulted in recovery of approximately five times the tonnage originally sent to market. The stationary screens efficiently removed high ash particles without appreciable blinding. Life of the bronze screens was approximately 84 hr.

Screen cloth employed had the following specifications:

Mesh	16	20	24
Wire diameter, inches	0.018	0.016	0.0135
Opening, inches	0.0445	0.034	0.0282
Open area, per cent	50.7	46.2	45.8
Launder orifices	½ in. diam		

At Lansford Colliery, the No. 4 Buckwheat (3⁄32 by 1⁄32 in.) and No. 5 Buckwheat (1⁄32 in. by 0) products were originally cleaned in a combined feed product by twelve concentrating tables. Because of the large range in particle size of this feed, table efficiency was very low. Furthermore, increased feed tonnages caused by a greater feed to the cleaning plant necessitated that increased cleaning capacity be provided or that proper sizing of the feed into the separate products be accomplished. Also removal of some of the fine high ash particles ahead of the tables seemed desirable. Accordingly launder screens were installed for this purpose as shown in Fig 4. Two screening circuits operating in parallel were constructed to handle the total tonnage of anthrafine feed. The flow diagram of one of the parallel screening circuits is shown on Fig 5.

Water for screening is provided by pumping part of the overflow from the anthrafine settling tank to the screens. Considerable fine high ash material is thus added to the circuit. However, this objectionable material is removed by the 24 mesh screen and is discarded. Preliminary operating results of this circuit are given in Table 3.

Wash water containing 5.93 pct solids at 36.99 pct ash was used for screening. As a result, 18 tons per hour of these high ash solids were introduced into the circuit. If clean water was available, considerable improvement would result in the screening and subsequent cleaning circuits.

Table 4 gives additional operating results of the launder screen when used for producing a sized product.

A 16 mesh screen is used to affect a 28 mesh cut. The velocity of the material passing over the deck reduces the size of particles which pass through screen openings. The oversize product, or the No. 4 feed, carries 77.4 pct of the plus 28 mesh material in the feed. Undersize in the product amounts to 9.24 pct. Overall screening efficiency for this screen at an effective cut of 28 mesh is 85.9 pct.

The secondary screen was dressed with approximately 70 pct 20 mesh cloth and 30 pct 24 mesh cloth at the time the samples were procured, for which analyses are given in Table 4.

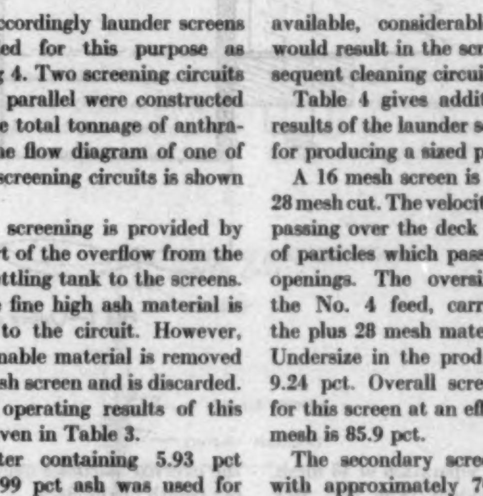


FIG 6—Settling tank circuit, Coaldale Colliery.

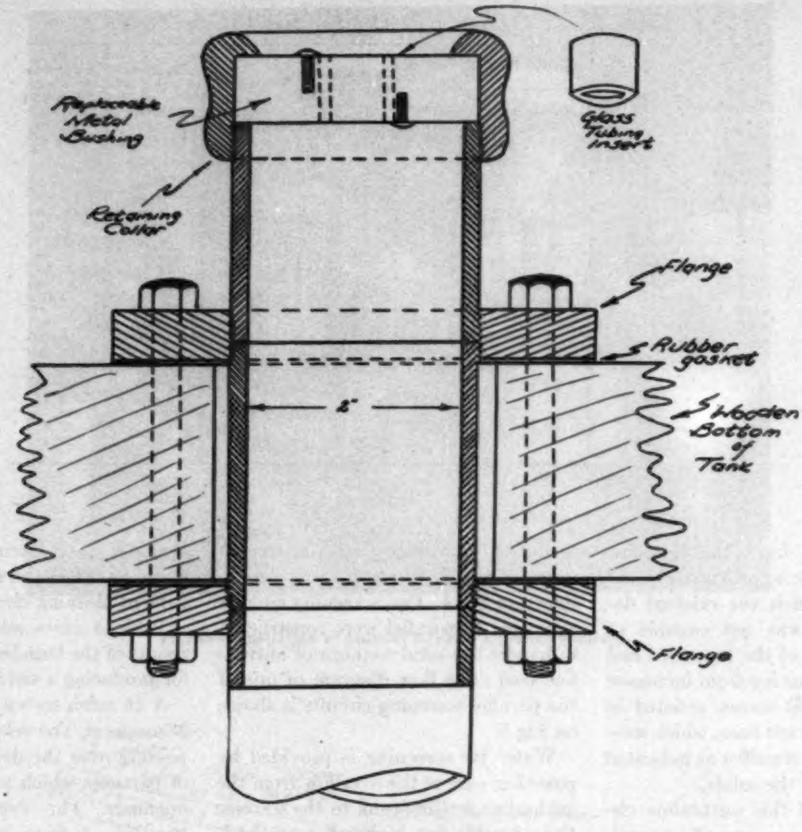


FIG 7—Orifice design.

For an effective separation of 48 mesh, the oversize product from this deck carried 81 pct plus 48 mesh particles. Overall screening efficiency at 48 mesh is 80.7 pct. The undersize product from this screen carried more plus 48 mesh material than desirable because of the use of some 20 mesh screen. A more desirable separation is made with all 24 mesh cloth on this secondary screen as indicated by the data in Table 3. A complete size analysis of a 24 mesh cloth underflow is shown in Table 5.

When used for sizing, the flow over the launder screen should be regulated so that essentially all the water has been removed through the cloth by the time the flow reaches the discharge point. Only sufficient water should be allowed to overflow the end of the screen to provide continuous removal of the oversize particles. When dirty water is used for screening, a good practice is to remove all this water through the screen several feet from the end of the screen. Sufficient clean water should be added to this point to flood the oversize particles over the remaining length of the deck.

For comparison with the bronze screen cloth, a stainless steel wire cloth was recently placed in service. Longer life and less blinding is obtained with this screen, as compared with the bronze cloth. Minimum life of the stainless steel cloth was 450 hr. Most of the cloth originally installed is still in service at the writing of this paper.

One of the problems encountered with the launder screen is blinding from a hair or fiber-like material, which requires the running of a steel brush over the deck occasionally. This material may be wood fiber, excelsior, or hay. The use of fresh water for screening rather than dirty, recirculated water will undoubtedly overcome this difficulty to a great extent.

Table 5 . . . Size Analysis of 24 Mesh Cloth Underflow

Retained on	Material, Per Cent	Ash, Per Cent
35 mesh	0.7	30.11
48	5.3	
65	13.6	41.98
100	16.5	
150	11.6	41.59
200	8.0	
−200	44.3	54.62
Composite	100.0	46.79

Coaldale Colliery Anthrafine Plant

Recovery of No. 4 Buckwheat ($\frac{3}{32}$ by $\frac{3}{64}$ in.) and No. 5 Buckwheat ($\frac{3}{64}$ in. by 0) at Coaldale Breaker was made by settling the raw feed (representing the $\frac{3}{32}$ in. underflow from the main sizing shakers) in a 12 ft 6 in. settling tank. This settling tank was originally 21 ft 6 in. in diameter but was reduced in size because of inadequate markets and difficulty in cleaning the finest particles. With the increasing demand for fine sizes of anthracite created during World War II, additional tonnages of classified feed were recovered by

Table 6 . . . Coaldale Anthrafine Settling Tank Operating Results

Sample Number	1	2	3	4	5
	Final Overflow Tank, 21 Ft 6 In.	Underflow of 12 Ft 6 In. Tank Feed to Original Anthrafine Plant	Underflow of Outer Tank through Orifices Feed to Screens	Underflow 30 Mesh Screens	Coal Product Screen Oversize
Flow, GPM	5000				
Solids, Per Cent	6.04				
Solids, TPH	78	101	45	15	30
Ash Content, Per Cent	33.60	29.98	24.72	35.96	14.69

Size Analysis	1 Weight, Per Cent	1 Ash, Per Cent	2 Weight, Per Cent	2 Ash, Per Cent	3 Weight, Per Cent	3 Ash, Per Cent	4 Weight, Per Cent	4 Ash, Per Cent	5 Weight, Per Cent	5 Ash, Per Cent
+8			2.0	20.2					0.1 }	11.9
+10			16.0	22.2	0.2 }	10.3			0.9 }	
+14			14.4	17.5	0.5 }				1.0	8.2
+20			23.6	28.9	3.5	9.4	0.1 }		8.5	9.2
+28	0.4 }	17.9	18.1	29.0	10.3	9.1	0.2 }	15.44	22.4	9.2
+35	1.6 }		11.1	38.9	17.8	12.0	5.3 }		33.8	12.6
+48	4.0	15.9	5.8	46.5	17.7	17.8	15.4	20.9	18.2	18.7
+65	6.4	14.9	3.0	50.4	14.5	25.1	19.0	29.0	7.8	24.3
+100	13.6	20.2	2.3	49.7	13.2	34.4	21.2	39.0	4.2	33.7
+150	10.8	25.21	1.3	42.3	7.4	40.4	13.5	45.3	1.3	38.2
+200	10.4	29.54	0.8	39.9	3.4	40.7	7.0	44.8	1.0	37.2
−200	52.8	43.5	1.6	41.8	11.5	45.5	18.3	47.0	0.8	36.6

using the space between the inner and outer tanks. Material which settles in this area is discharged through a series of orifices placed in the bottom of the tank. Fig 6 shows the design of the settling tank and the position of the underflow orifices. The flow diagram also shows that the classified solids recovered through the orifices are screened over two vibrating screens to remove the high ash fines and thus produce a satisfactory product for market.

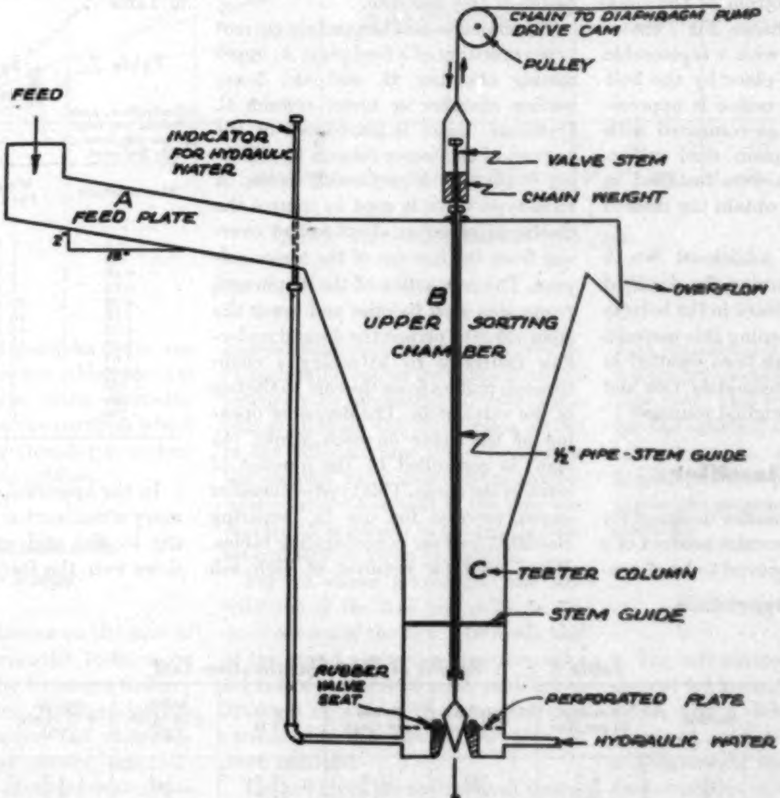


FIG 8—Oversize classifier.

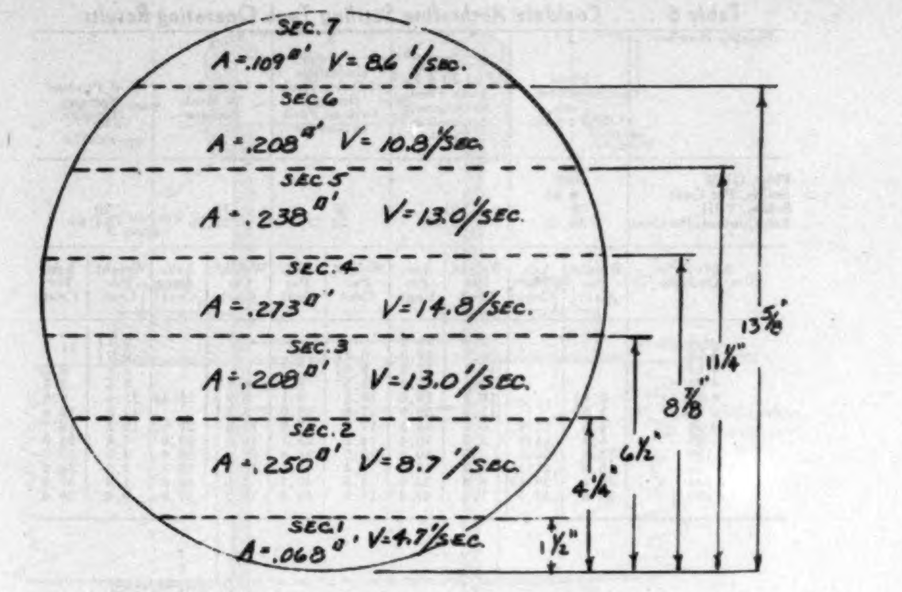


FIG 9—Wood pipe (15¾ in. diam) sections sampled and analyzed for classification test.

Operating results of this circuit are given in Table 6.

Several types of replaceable orifices were used in the bottom of the tank to regulate the discharge. Fig 7 shows one type of orifice with a replaceable glass insert held in place by the bolt heads. Life of this orifice is approximately one month as compared with two weeks for a plain steel orifice. Twenty-five orifices were installed in the tank bottom to obtain the desired discharge flow.

The recovery of additional No. 5 anthrafine by discharging the classified material through orifices in the bottom of the tank and screening this material to eliminate high ash fines resulted in an increase of approximately two and one-half times the original tonnage.

Pocket Classifier

A small pocket classifier designed for use in treating the oversize product of a flotation plant has proved to be of considerable help to remove pyrite and high ash particles from the underflow of a hydroclassifier. Fig 8 shows the design of this machine.

The classifier is of the surface current type consisting of a feed plate *A*, upper sorting chamber *B*, and the lower sorting chamber or teeter column *C*. Hydraulic water is introduced at the bottom of the teeter column by diffusing it through a perforated screen. A stem-type valve is used to control the discharge of refuse or classified oversize from the bottom of the teeter column. The cam action of the diaphragm pump was used to raise and lower the stem valve to permit the desired underflow discharge by attaching a chain through pulleys from the cam to the top of the valve stem. The degree of opening of the valve on each stroke (45 rpm) is controlled by the amount of slack in the chain. This type of classifier shows promise for use in preparing classified feed for concentrating tables. When used for removal of high ash particles from a feed of 140 gpm at 32 pct solids, a typical underflow sample from an 18 by 24 in. classifier is given in Table 7.

Table 7 . . . Typical Underflow Sample

Underflow, gpm	11
Solids, per cent	40
Tons per hour	1.1
Ash, per cent	58.41

Size Analysis	Weight, Per Cent	Ash, Per Cent
+6	0.9	
+8	1.3	
+10	4.2	48.34
+14	7.6	
+20	23.4	
+28	18.8	56.65
+35	14.8	
+48	12.5	63.3
+65	8.4	
+100	5.4	74.0
+150	1.7	
+200	0.6	67.0
−200	0.4	57.5

In the operation of the classifier, primary stratification takes place according to size and gravity as the pulp flows over the feed sole or plate. The

Table 8 . . . Results of Pipe Classification Test

Section	Velocity Ft per Sec	Discharge, GPM	Solids, Per Cent	Solids, TPH	Solids +28 Mesh, TPH	Solids +35 Mesh, TPH
1	4.7	145	17.8	7.0	3.4	4.5
2	8.7	977	7.0	17.5	3.3	5.9
3	13.0	1,220	5.0	15.5	1.3	2.8
4	14.8	1,830	4.4	20.6	0.8	1.6
5	13.0	1,400	3.7	13.0	0.2	0.6
6	10.8	1,020	3.0	7.7	0.1	0.3
7	8.7	425	2.5	2.8		
Composite	11.5	7,000	5.36	95		

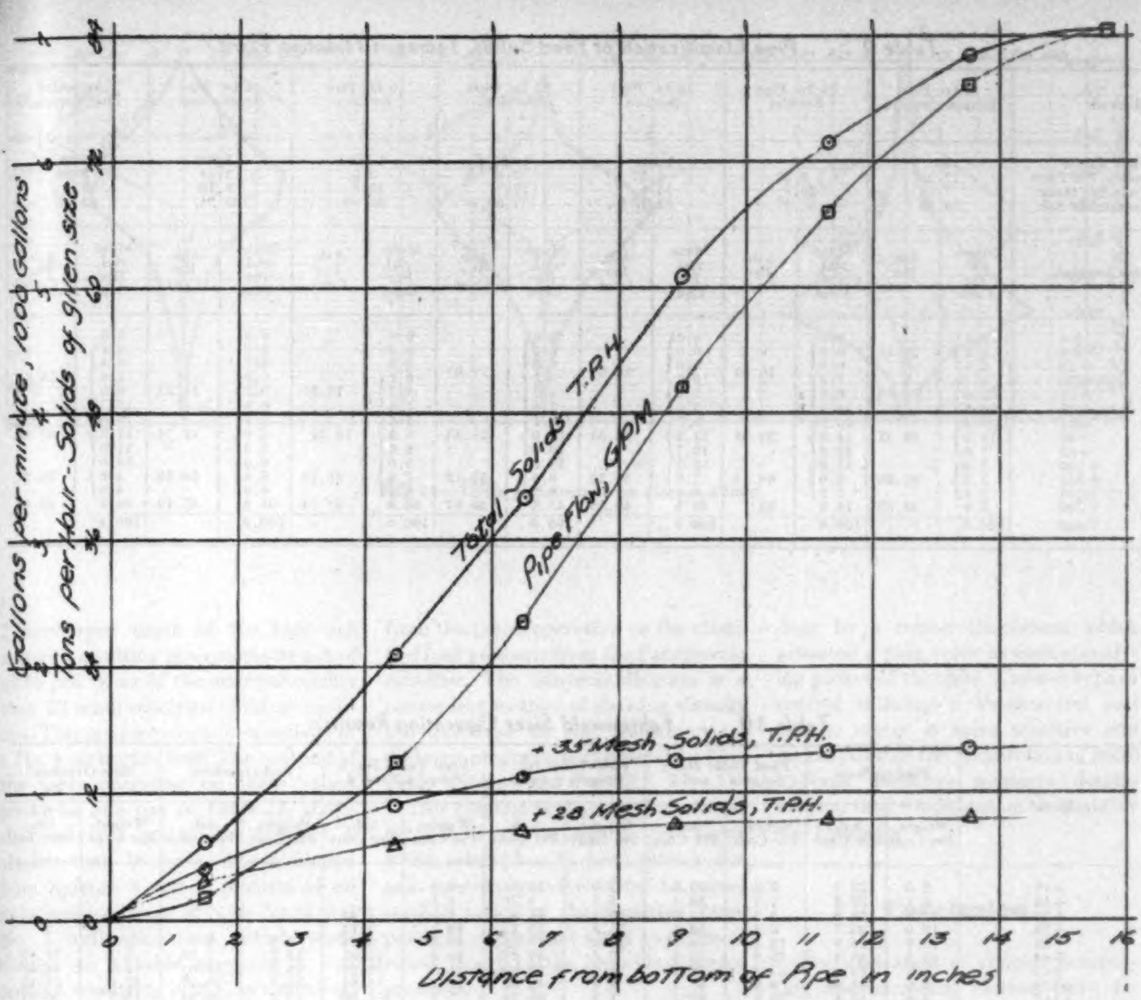


FIG 10—Flow characteristics of 16-in. pipe.

partially stratified particles enter the upper sorting chamber which sloughs off the lightest and finest particles. Final separation on the particles which settle in the upper chamber is accomplished in the teeter column.

Classification in Pipe Flow

A test was conducted on the flow of silt-laden water from the 16-in. wood pipe line feeding the Tamaqua Colliery froth flotation plant to determine the amount of segregation and classification of solids that occurs. Approximately 7000 gpm of slurry water was passed through 400 ft of pipe. Sampling of the line was done by introducing a slicer at different elevations in the cross section of the pipe and procuring samples from each section. The velocity of each pipe section was approximated relatively by measuring the rate of discharge through the slicer when placed in the different pipe zones to procure the samples. Fig 9 shows the manner in which the cross section of the pipe was divided. A summary of the results from several tests is given in Table 8.

Fig 10 shows graphically the distribution of the flow and solids in the cross section of the flow. The lower half of the pipe flow carries approximately 8.4 tph of the plus 28 mesh particles in 3200 gal of water. The upper section carries only 0.7 tph of the plus 28 mesh material.

Table 9 gives the size and ash analyses of the solids recovered in the various cross-section zones of the pipe except for Zone 7 which was not sampled on this particular test. These data indicate that considerable classification of the suspended particles takes place in the pipe flow. This condition makes possible the splitting of the flow into separate zones to enable the separate handling of that part of the flow which carries the preponderance of the desired particles.

Fahrenwald Sizer

The advantages obtained from improved table operation by feeding the tables with a classified feed have been discussed much in the past. The use of a Fahrenwald sizer on an anthrafine feed consisting of both No. 4 anthrafine (3/32 by 3/64 in.) and No. 5 (3/64 in. by 0) sizes will be described by data in Tables 10 and 11. Data on sizer performance in Table 10 indicates that Spigots 1 and

Table 9 . . . Pipe Classification of Feed Solids, Tamaqua Flotation Plant

Marked	16 In. Pipe Bottom Section 1		16 In. Pipe Section 2		16 In. Pipe Section 3		16 In. Pipe Section 4		16 In. Pipe Section 5		16 In. Pipe Section-top 6		Composite Pipe Sample	
Flow, GPM	145		977		1,220		1,830		1,400		1,020		7,000	
Solids, Per Cent	17.25		8.23		4.67		3.8		3.5		3.14		5.36	
Tons Per Hour	7.0		20.6		14.6		17.7		12.5		8.10		95	
Composite Ash	24.85		31.97		33.28		34.50		36.94		38.21		32.25	
Size Analysis	Material, Per Cent	Ash, Per Cent	Material, Per Cent	Ash, Per Cent	Material, Per Cent	Ash, Per Cent	Material, Per Cent	Ash, Per Cent	Material, Per Cent	Ash, Per Cent	Material, Per Cent	Ash, Per Cent	Material, Per Cent	Ash, Per Cent
+6	0.1		0.0		0.0		0.0		0.0		0.0		0.0	
+8	0.2	25.44	0.0		0.0		0.0		0.0		0.0		0.1	
+10	2.6		0.3	16.03	0.0	10.86	0.0	19.83	0.0		0.0		0.4	
+14	2.7		1.2		0.2		0.2		0.2		0.2		1.0	18.08
+20	22.0	16.59	8.5		2.3		1.2		0.2	13.26	0.2	14.23	6.5	
+28	19.5		14.0		5.0		2.6		1.4		0.6		10.7	
+35	15.0		16.2		9.7		2.4		3.4		2.0		12.5	
+48	10.2	28.41	14.8	33.36	11.0	24.53	13.0	21.33	5.4	14.51	4.0	12.74	11.5	32.48
+65	7.8		12.2		10.7		10.0		6.6		6.0		11.0	
+100	7.0		11.0		12.2		13.0		9.0		9.0		10.0	
+150	3.5	41.86	5.0	40.14	7.5	36.30	8.4	33.12	7.0	28.13	6.8	26.50	5.5	36.27
+200	2.5		2.5		5.0		6.0		6.0		6.0		4.0	
−200	6.9	43.57	14.3	53	36.4	46.15	43.2	46.67	60.8	47.94	65.2	47.19	26.8	43.44
Total	100.0		100.0		100.0		100.0		100.0		100.0		100.0	

Table 10 . . . Fahrenwald Sizer Operating Results

Mesh	Feed to Sizer		Feed Table No. 1 Spigots 1 and 2		Feed Table No. 2 Spigots 3 and 4		Feed Table No. 3 Spigots 5 and 6		End Overflow		Side Overflow	
	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent
+10	2.6	22.5	0.8	23.3	1.0	10.36	0.0					
+14	6.1	22.8	1.7	30.1	5.7	9.20	0.1					
+20	12.4	22.8	3.1	34.2	18.1	11.6	1.2	7.62				
+28	18.0	24.7	6.1	43.3	31.8	15.15	10.1	7.13				
+35	18.0	26.9	13.1	60.9	24.3	27.23	27.5	8.75	2.6	8.0		
+48	13.7	30.3	23.9	74.8	7.0	49.25	29.0	10.05	15.5	7.35	4.1	10.62
+65	10.5	34.2	27.3	82.5	6.2	72.65	16.6	28.09	26.3	10.61	15.3	14.52
+100	9.6	44.9	4.9	87.3	4.1	86.05	10.3	68.94	25.3	23.17	27.0	32.42
+150	4.8	53.6	17.2	87.2	1.3	90.78	3.7	81.86	13.2	38.52	15.5	38.77
+200	1.8	52.7	1.5	72.0	0.3	76.60	0.9	85.39	5.8	54.29	8.7	50.0
−200	1.2	58.1	0.4		0.2		0.6	75.46	11.6	51.15	29.4	53.24
Composite												
Ash, per cent		29.05		43.46		30.41		24.05		24.87		34.76
Solids, per cent	45.7		50.0		48.0		30.0		9.9		6.7	
Long tons per hour	26.3		7.0		7.7		7.3		0.2		4.1	

Table 11 . . . Table Performance on Classified Feed

Mesh	Table No. 1 Spigots 1 and 2				Table No. 2 Spigots 3 and 4				Table No. 3 Spigots 5 and 6			
	Coal		Refuse		Coal		Refuse		Coal		Refuse	
	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent
+10	9.5	11.57	1.6	79.41	1.1	8.40	0.1	33.59	0.7	9.41		
+14	25.5	11.88	7.2	79.74	8.4	7.80	0.8	38.62	2.1	10.83	1.3	65.82
+20	39.3	11.51	16.1	74.39	27.3	8.59	3.8	39.2	5.1	12.70	1.3	74.15
+28	21.3	11.90	27.7	65.20	39.5	9.59	16.4	44.66	14.3	11.37	2.5	66.60
+35	3.1	13.27	24.0	67.38	18.4	12.01	31.9	61.08	29.5	10.79	5.7	52.87
+48	0.6	29.14	12.2	75.90	4.0	16.61	23.1	75.90	28.3	13.57	12.9	48.65
+65	0.9	54.91	6.2	81.67	0.8	27.07	12.8	87.73	13.3	20.66	23.7	59.28
+100			3.7	88.46	0.2	53.40	8.2	86.92	5.3	39.49	33.4	81.34
+150			1.0	88.76	0.3	60.14	2.3	87.08	1.2	60.74	14.2	88.53
+200			0.3	78.56			0.4	72.67	0.3	72.39	3.3	89.54
−200							0.2	60.75	0.3	60.43	1.7	85.44
Composite												
Ash, per cent		12.28		76.25		10.70		60.75		17.52		70.58
Long tons per hour	3.3		3.7		4.9		2.8		6.1		1.2	
Solids, per cent	17.3		53.4		16.4		48.7		No Data			

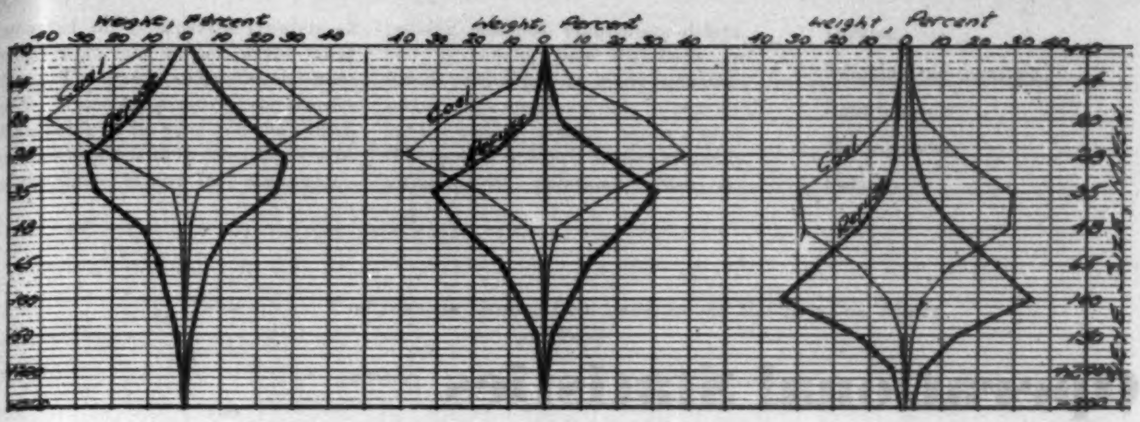


FIG 11—Table performance on classified feed.

2 discharged much of the high ash material resulting in a composite ash of 43.46 pct. Most of the material smaller than 28 mesh consisted of refuse particles. This product consists essentially of a No. 4 anthrafine feed. The coal end of the table operating on these spigot products, analysis in Table 11, shows that only 4.6 pct of the product is smaller than 28 mesh. The discharge from Spigots 3 and 4 consists of an in-between product of both No. 4 and No. 5 anthrafine feed, which when cleaned on a table produced a coal product consisting of 23.7 pct material smaller than 28 mesh. Table performance on both spigot products was good, with satisfactory coal and refuse products. The discharge from Spigots 5 and 6 consisted essentially of a No. 5 anthrafine feed with only 11.4 pct plus 28 mesh material present. Table performance on this product was not as good as on the previous products because part of the fine high ash particles reported to the coal product to build the ash content to 17.52 pct. However, by reducing the tonnage to this table and adjusting the table variables, a satisfactory product could have been obtained.

Fig 11 shows graphically by use of bilateral diagrams the difference in size of the refuse and coal products from the tables operating on the classified feed products from the Fahrenwald classifier. The bilateral diagram is a convenient method of showing visually the difference in size consistence of different products as explained by Coe, Feld, Williams and Coghill.*

This diagram is of particular interest because it shows clearly the sizing which takes place by both particle size and specific gravity. Due to equal settling ratios of the particles, large particles of coal and small particles of refuse report to the individual spigot products.

It is because of this difference in size of the low gravity and high gravity particles from a given spigot that the tables are able to perform efficiently on a classified feed.

The decreasing size of the products, both coal and refuse, discharged from the succeeding spigots can also be noted by comparing the various product curves.

Table performance can be improved by the preparation of classified feed to the tables. Control of the spigot discharge from the Fahrenwald sizer was done by a rubber diaphragm which actuated a plug valve in each classifying pocket of the sizer. A newer type of control utilizing a Pressuretrol and electric motor is more sensitive and makes possible the preparation of more uniform discharge products despite varying feed conditions as to quantity and character.

* G. Dale Coe, I. L. Feld, M. F. Williams, Jr. and Will H. Coghill: Continuous Hydraulic Classification: Constitution of the Teeter Column Throughout Its Depth. U.S. Bur. Mines, *R.I.* 3851.

Conclusion

The utilization of simple classification and screening devices have resulted in improved recovery of No. 4 and No. 5 anthrafine at the cleaning plants of the Lehigh Navigation Coal Company Incorporated. These devices have been described with operating results to promote further thought and interest on means of improving the preparation of the fine sizes of coal. Considerable study must be made on the preparation of finest sizes since the present equipment and circuits are none too efficient.

The launder screen is a tool that can be used to advantage in numerous fine coal cleaning circuits. The operating data procured when used to prepare a sized product indicate that a closely sized product can be attained at high screening efficiency.

Operational Statistics of a Marion 5560 Power Shovel

By GEORGE B. CLARK,* Member AIME, and GEORGE L. REITER†

Strip Mining

COMMERCIAL strip mining of coal was first begun in the state of Illinois in 1911.[1] The annual tonnage of coal produced from coal strip mines in the state was very small until 1924, when the strip mines shipped 1.68 pct of the total state shipping mine tonnage. Since then, strip mines have gradually come into their own by producing a sizable percentage of the coal produced in the state. Table 1 shows the coal tonnage shipped from both underground and strip coal mines in the state of Illinois for selected years. The table illustrates the major role that strip mines play in the state's coal industry.

Today, strip mining is generally conducted in areas where the coal seams lie so close to the surface of earth that a stripping method of mining the coal seam is cheaper than an underground method. Strip mining not only recovers 100 pct of the coal deposit, but may also be used as a method of mining large acreages of coal abandoned by the closing of underground mines.

Open cut or strip mining is a very highly mechanized method of producing coal and is carried on in three distinct and separate operations. The first of these is uncovering or exposing the coal seam so that the coal is made available for mining. The second operation is that of actually mining the coal. The third operation is the washing, crushing and grading of the coal according to the producer's market.

Description of Shovel

The Marion 5560 power shovel is used in the first of these three operations. The large electric-powered shovel works forward and back across the coal deposits, removing the overburden of dirt, rock, and clay in successive cuts of 30 to 60 ft deep and 40 to 80 ft wide. The shovel has a maximum cutting height of 95 ft, but around 60 ft is considered to be the maximum economical cutting height by the operators. The smaller the depth of cut, the more economically the shovel will operate until a minimum cut of 15 ft is reached, below which the efficiency decreases rapidly.

The Marion shovel may be used in tandem stripping in excessive depths of overburden. The other type of excavating equipment used in the tandem team is generally a dragline with a long boom of about 180 ft. In tandem stripping, the dragline is used to remove the upper portion of the cut and to place it at a maximum dumping radius from the place of removal. The Marion 5560 power shovel is then used to remove the overburden left above the coal seam and to deposit it at the shovel's maximum dumping radius.

The Marion 5560 power shovel is of gigantic proportions. It has a 102 ft 6 in. boom and 32 cu yd dipper and is

San Francisco Meeting, February 1949.

TP 2531 A. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before April 30, 1949. Manuscript received June 28, 1948.

* Assistant Professor of Mining Engineering, University of Illinois, Urbana, Ill.

† Student, University of Illinois.

[1] References are at the end of the paper.

mounted on 8 separate crawlers—2 crawlers at each corner of the lower frame. The crawler units at each corner of the frame are massive—the crawler belts being 42 in. wide and the overall crawler length is 19 ft. Since the weight of the shovel is over 1600 tons, whenever it is desired to move the shovel over a weak-surfaced strata, it is necessary to place large timber matts over the surface for the shovel to drive on.

There are two hoisting motors of 350 hp each that drive a single-reduction herringbone gear drive for the 65-in. hoisting drum. Power for rotating the shovel's upper frame is supplied from 3 motors of 125 hp each.

The shovel has dual control stations —one on each side of the boom. Thus the operator has excellent visibility of the operations at all times for either direction of swing or travel, and he may choose the side of boom from which he desires to work. Normally only two hand and two foot controls are used for digging, swinging, dumping, and return swing. A large control panel for other adjustments that may be required is placed in the center.

The massive dipper is built up of castings and plates welded together so they form as a single unit. The cutting edge of the dipper has seven large, replaceable cutting teeth weighing around 200 lb each.

Table 1 . . . Coal Tonnage Shipped from Underground and Strip Coal Mines in Illinois[3]

Year	All Mines		Strip Mines Only			
	Total Tonnage Produced	Number of Mines	Number of Mines	Per Cent of Number Mines	Total Tonnage Produced	Per Cent of Total Tonnage
1946	60,932,785	160	36	22.5	14,302,739	23.47
1940	46,071,806	139	27	19.4	12,024,635	26.10
1935	41,410,414	182	28	15.4	7,088,104	17.11
1930	51,996,608	185	15	8.11	6,220,336	11.96
1924	70,324,363	338	11	3.25	1,184,288	1.68
1920	72,409,610	373	3	0.80	367,009	0.50

Time Studies

The time study is one of the most useful tools of modern production management. If properly conducted, it not only provides the information necessary to set production standards, but furnishes the basic data for improving methods, eliminating delays, and developing time standards for future production. In many industries such studies are aimed only at appraising the quality of labor, but in general this type of study is made on highly standardized operations which are repeated many times under identical conditions. To be completely informative, however, time studies should yield information not only concerning: (1) the quality of labor, but also (2) the quality of machinery, and (3) the quality of working conditions.

Table 2 . . . Time Distribution for 1947

	Hour	Minutes
A. Overall operating time:		
Digging	5,584	03
Moving	444	46
Delays	2,155	11
	8,184	00
B. Productive time:		
Digging	5,584	03
Moving	444	46
	6,028	49
C. Delay time:		
Electrical failure	299	12
Mechanical failure	1,033	33
Power failure	78	41
Miscellaneous	743	45
	2,155	11

In some mining operations the various elements of a given operation may be classified as "constants" or "variables." In stripping operations, however, none of the elements of the operation cycle seem to fall into the class of "constants."

The analytical methods of time studies are very readily applicable to the operation of a large stripping shovel. For the purposes of such a study the operation may be reduced to the following elements:

1. Digging
2. Swinging and dumping
3. Return swing
4. Moving shovel
5. Delays

The shovel is equipped with a device in the cab which records the time of these factors on a moving tape. The record is made in such a manner as to show the degrees of arc swung by the boom. Daily records are taken from the tape and are transferred to ledgers. From these ledgers monthly and yearly summaries are made. Table 2 is such a summary for the year of 1947. The shovel's entire operation period of 8184 hr has been broken down into (1) operating time and (2) delay time. These in turn have been separated into their elemental components.

ACTUAL STRIPPING TIME

Fig 1 to 3 show the time distributions from Table 1 in graphically illustrated form. These graphs show readily that during the year of 1947 a total of 8184 hr were credited to the shovel, but only 5584 hr, or 68.1 pct of the time, was used in actual stripping operations. Of the total operation time, 5.4 pct was employed in moving the shovel progressively to new adjacent operating positions. These figures yield an overall "efficiency" of 73.5 pct for the year of 1947. "Power failure" was that due to storms, and other reasons, outside of the company property. "Electrical failure" was that due to causes on company property.

The aggregate amount of moving involved was 114,816 ft. Because of its enormous size and weight, the shovel travels slowly. It normally requires

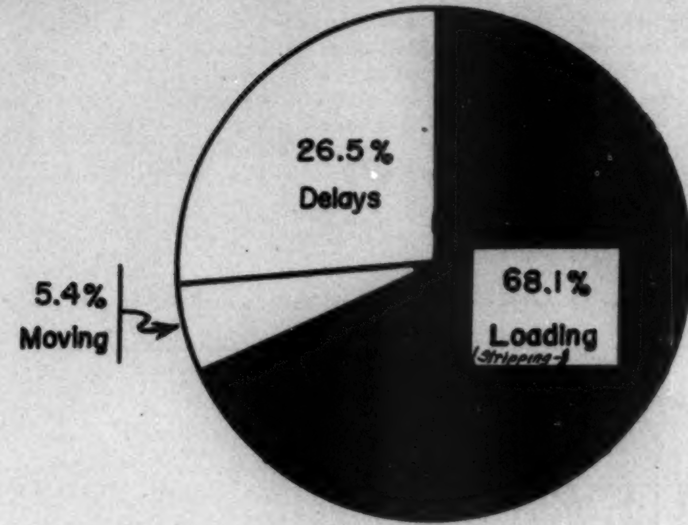


FIG 1—Overall time distribution.

about 3 min and 50 sec to travel 18 ft and relevel for digging.

Table 3 presents an average time distribution for an operating period of about 4 hr. Observed times were recorded from a stop watch and the degrees of swing were estimated. Fig 4 is

Table 3 . . . Time Distribution for 102 Observed Dipper Cycles

	Per Cent
Swing	26.4
Dump and return swing	30.8
Digging	42.8
	100.0

a graphical representation of the average proportionate time obtained by this method.

Because of the fact that dumping and swinging operations overlap, it is very difficult to segregate the actual time required to dump the dipper. However,

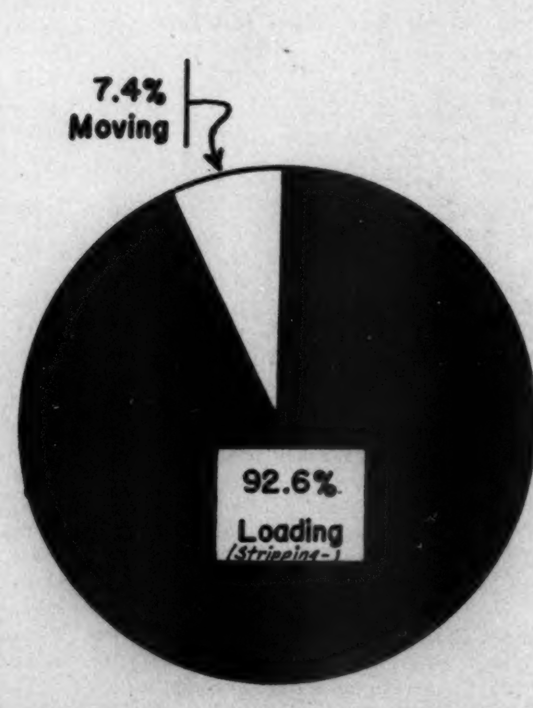


FIG 2—Time distribution for productive operations: moving, and loading and dumping.

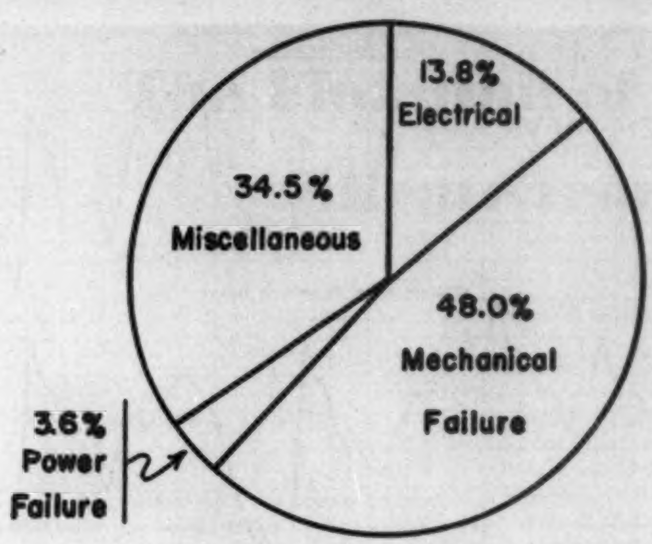


FIG 3—Time distribution of delays.

the time normally varied between 3 to 6 sec for the dipper to be dumped and the shovel to begin the reverse swing. The digging stroke time represented in Fig 4 is slightly higher than in the average digging stroke in stripping because of the fact that several cleaning strokes must be made each time the shovel is moved. The range of time for each element of the cycle varied between the following limits:

Dig	14 to 110 sec
Swing	11 to 27 sec
Dump and return swing	15 to 28 sec
Angle of swing	40° to 180° (one way)

The wide variation in the time consumed per digging stroke was caused by the variation in depth and hardness or compactness of the material, as well as by the fact that certain of the strokes were required for cleaning up.

In Fig 5 the time per cycle and the angle of swing are plotted as ordinates with the dipper number along the horizontal axis. As might be expected, there is not an exact correlation for each individual dipper cycle, but the general trends are parallel. That is, as the angle of swing increased, the time per dipper increased also. The swinging and dumping time is almost constant for a given angle of swing, the variation in time per dipper being almost wholly due to the variable time required to fill the

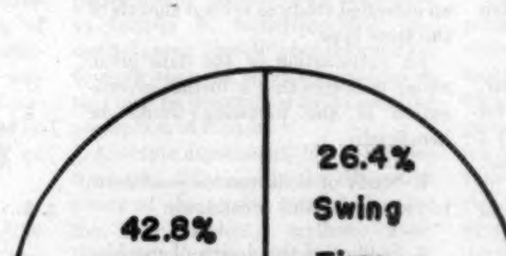


FIG 4—Time distribution for elements of digging cycle for a short period of 4 hr.

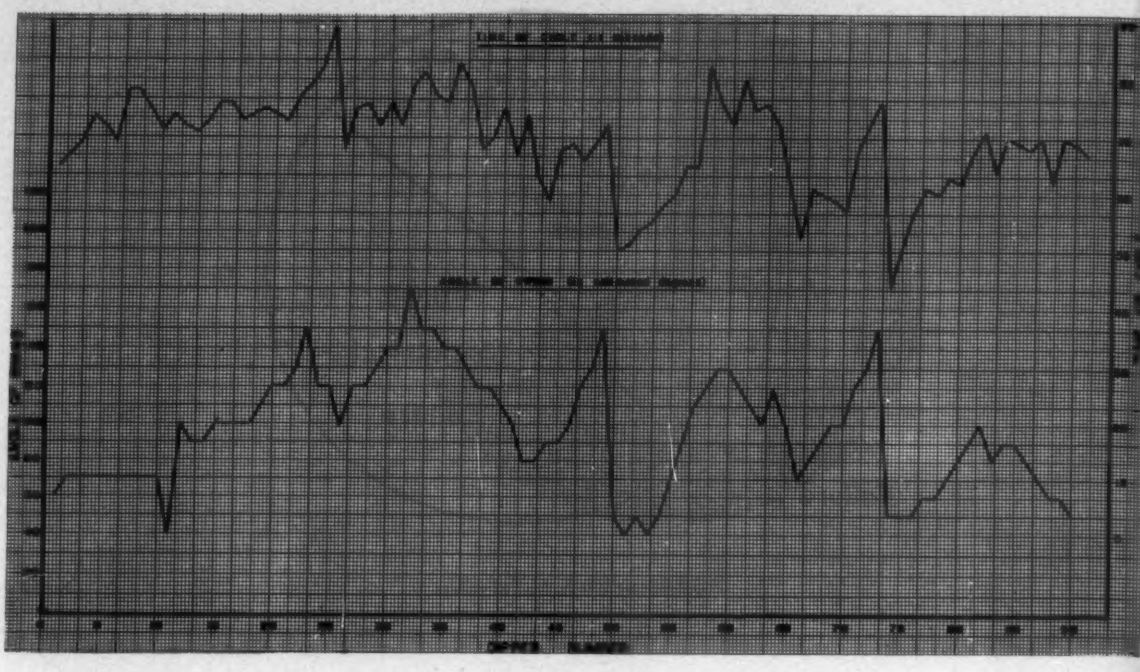


FIG 5—Relation between time of cycle and angle of swing.

dipper in hard or soft ground.

During 1947, the shovel consumed 3,267,800 kw-hr of electrical power. This consumption was segregated into averages of:

0.409 kw-hr per cu yd of overburden moved.

12.76 kw-hr per swing.

585 kw-hr per actual digging hour. During this same period the shovel made 256,087 swings, averaging 31.2 cu yd per swing in 1.31 min per cycle. This average load obtained with a 32 cu yd dipper represents a utilization of operational capacity of 97.5 pct.

DELAYS

The total delay time may be broken down as shown in Fig 3. (See also Table 2C.) The greatest loss of time was caused by mechanical failure and the second largest to miscellaneous delays such as moving power cable, oiling, blasting, and others. Power failures and electrical failures were the result of such causes as electrical storms, ice and sleet, and other power transmission difficulties. Reduction in the number of mechanical failures will come about as a result of improved design and manufacture of machine parts, and increased experience of the operators.

Whether the total delay time of 26.5 pct is excessive for this type of equipment could only be determined after an extended study of several shovels of the same type.

An examination of the data given above indicates that a further investigation of the following would be beneficial:

1. Study of maintenance procedures to reduce machine breakdown.

2. Studies of the design of machine parts to prevent breakdown.

3. Study of causes of power failure and their possible elimination.

4. Causes of miscellaneous delays and their reduction.

Acknowledgment

The Marion 5560 shovel described in this paper is located at the property of the Northern Illinois Coal Corporation at Wilmington, Illinois. The data summarized in Table 3 were recorded by Mr. Reiter, one of the authors. Other figures were supplied through the courtesy of the Northern Illinois Coal Corporation.

References

1. The Open Cut Coal Mining Industry of Illinois. Illinois Coal Strippers Assn. (December 1939.)
2. R. M. Medill and R. Weir: 65th Coal Report of Illinois, 1946. P. 43, Department of Mines and Minerals.
3. R. S. Lewis: Elements of Mining. P. 310. 1946. John Wiley and Sons.
4. Coal Stripping with Marion Shovels and Draglines. The Marion Steam Shovel Co. *Bull.* 392, p. 31.
5. Northern Illinois Coal Corporation, Wilmington, Illinois, Unpublished, 1947–1948.
6. V. C. Stephens: Production Management. *Coal Age* (March 1948) 84–88.
7. G. S. Watkins and P. A. Dodd: The Management of Labor Relations. Pp. 41–43, 1938. McGraw-Hill Book Co.

The Flotation of Copper Silicate from Silica

By R. W. LUDT* and C. C. DeWITT,* Member AIME

THE use of froth flotation for the separation of minerals has become one of the most important of ore dressing processes. Its particular adaptability to the enrichment of low grade ores has made the process an important factor in the national economy. The methods have been extended to the recovery of a great number of minerals. Among the few minerals which have resisted efforts toward industrial flotation is chrysocolla, a hydrated partly colloidal copper silicate.

Chrysocolla, being a product of natural oxidation, has been found to occur in small quantities with many ores which are recovered by flotation methods. In present practice, these small quantities of copper silicate pass off with the tailings and are lost. The advantages to be gained by a satisfactory process for the recovery of chrysocolla is apparent. Any application of principles which points a way toward the satisfactory industrial flotation process for copper silicate would be of advantage. This paper presents an attack on this problem.

Two methods for the recovery of chrysocolla have been developed by the United States Bureau of Mines.[1,2] They have been successful on a laboratory scale but have been seriously restricted in industrial application by critical requirements in the procedure.

In one of the Bureau of Mines methods,[1] the ore is activated with sodium or hydrogen sulphide in an aqueous solution at a pH of 4. Amyl xanthate is then used as a collector with pine oil as a frother in the flotation process. An excess of sulphide acts as a depressant and the state of optimum conditions is difficult to control industrially.

In the second Bureau of Mines method,[2] soap is used as the collector at a pH of between 8 and 9. The difficulties with this process are that soap is not a specific collector, that heavy metal or alkaline earth ions cause the formation of insoluble soaps, and that a more acid solution causes the formation of a free acid which does not act as a collector for chrysocolla.

The problem of recovering chrysocolla by flotation involves the selection of a suitable collector. The collector molecule must be composed of an active polar group that has an attraction for chrysocolla, and of a hydrocarbon chain.

Certain dyes have been shown to have an attraction for certain minerals. Suida[3] found that hydrated silicates are colored by basic dyes. Dittler[4] showed that chrysocolla, among other colloidal minerals of acid reaction, preferentially takes up such basic dyes as fuchsin B, methylene blue, and methyl green. Endell[5] gave information to show that the colloidal material in clay may be determined by its selective adsorption of fuchsin.

A simple experiment, likewise, illustrates the difference in the adsorptive power of chrysocolla and of silica for the basic triphenyl methane dyes. When a mixture of chrysocolla and silica is immersed in a very dilute dye solution, less than 5 ppm, the chrysocolla is rapidly dyed and the silica is dyed more slowly. The difference is substantial but one of degree. Dean[3] showed that the dyes, crystal violet and toluidine blue, are taken up by quartz in an adsorption type process. The difference in the adsorptive power, however, offers the means by which a new collector may act.

To form such a collector, a hydrocarbon chain must be attached to the dye molecule. This involves a process of organic synthesis.

Butyl, hexyl, and octyl hydrocarbon chains were selected for substitution in the malachite green molecule. For the purpose of identification, the alkyl-substituted dyes formed are called: butyl-malachite green; hexyl- malachite green; and octyl-malachite green. An outline of the procedure for their synthesis is given in the appendix.

It is generally recognized in the preparation of this type of dye that the chemical structure of some of the dye molecules varies. However, a uniform formula is attributed to the dye. Such a procedure has been followed in specifying the structure of these alkyl-substituted malachite green dyes. The structure is given on the basis of their properties as an homologous series of dyes, on their method of preparation, and on the purity of intermediates used.

Structure of substituted alkyl malachite green is:

$$
\begin{array}{l}
\qquad\qquad C_6H_4 \cdot N(CH_3)_2 \\
\qquad\qquad \cdot \\
p\text{-}R \cdot C_6H_4 \cdot CH \\
\qquad\qquad \cdot C_6H_4 \cdot N(CH)_2 \\
\qquad\qquad\qquad\quad \cdot \\
\qquad\qquad\qquad\quad Cl
\end{array}
$$

Procedure

The flotation cell is a Bureau of Mines 100-g, batch unit provided with an air inlet at the bottom above which is a variable speed agitator. The agi-

San Francisco Meeting, February 1949.

TP 2535 B. This paper is based on part of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Chemical Engineering.

Discussion of this paper (2 copies) may be sent to *Transactions* AIME before April 30, 1949.

Manuscript received at the office of the Institute June 28, 1948; revision received Nov. 29, 1948.

* Michigan State College, East Lansing, Mich.

[1] References are at the end of the paper.

tator and shaft are made of steel, the cell itself of lucite.

Froth discharges into a Buchner funnel where the concentrate is collected on filter paper. The liquid is drawn through the filter into a glass bottle by vacuum and is returned to the cell.

When the cell is charged, the total volume of pulp is made up of 100 g of solids and about 225 g of water. The exact amount of water in the cell depends upon the froth depth.

Flotation tests were run on synthetic ore mixtures of silica and chrysocolla. The minerals were ground separately in a wet charged ball mill, deslimed, dried, and screened. Only that material under 200 mesh was used in the tests.

Clean Ottowa sand was used as the source of silica. The chrysocolla was purchased from Ward's Natural Scientific Establishment, Rochester, N. Y.; this mineral was examined and identified by a minerologist. Dyed and undyed samples were examined under the microscope for colloidal and crystalline structure. Impurities of both crystalline and noncrystalline structure were found. If some of the impurities were crystalline copper-bearing minerals, they would not have been colored by the dye.[6] The sample of chrysocolla contained 23.5 pct copper.

Pine oil, as needed, was used as a frothing agent. The collector was added as an alcohol solution. The concentrate was recovered, dried, weighed and tested for copper by the method of Park.[7]

In some of the tests, the collector was added throughout the test in stage addition. The concentrate was continuously removed in the later runs, an induction period of 3½ min was allowed after each addition of collector. The induction period was included in the reported total flotation time.

Discussion of Results

In addition to the results shown in the report, many auxiliary runs were made to determine the general flotation procedure. Some of the conclusions from these preliminary tests are given below.

Particle size of the ore should be less than 200 mesh. This is well within the common particle size range in American industrial practice as summarized by Petersen.[8]

The presence of large amounts of slime, clay, or colloidal material complicates the recovery procedure. All of these materials should be removed before the flotation of chrysocolla.

The amount of air admitted to the cell influences the percentage of copper obtained in the concentrate. A large amount of air causes sufficient agitation to materially increase the amount of sand carried over in the concentrate. The quantity of air used in the runs was not measured and can be expected to give rise to some variation in results.

The use of common depressants such as tri-sodium phosphate, sodium silicate, acetic acid, hydrochloric acid, hydrofluoric acid, sodium hydroxide, and sodium carbonate show either no material improvement or a detrimental effect. All acid solutions that were used depress the chrysocolla. The use of sodium carbonate indicates some possibility for improved recovery.

The main purpose of the flotation tests is to show that appreciable recovery of chrysocolla from silica can be made by the use of an alkyl-substituted triphenyl methane dye when used as a collector. Optimum conditions of operation are not established but the influence of certain factors are noted. Operating conditions are found to have a great effect on the results. Check results vary to a great extent unless exact conditions are maintained.

The relative effectiveness of the three homologues of alkyl-substituted malachite green as a collector for chrysocolla is shown by a comparison of Runs 32, 31, and 34, in Table 1. The octyl malachite green is much superior to the compounds with the shorter hydrocarbon chains. All of the results shown in Table 1 are inferior to others shown in the report but they serve as a comparison for the three collectors. Only the octyl dye indicates possibilities as an industrial collector for chrysocolla.

As in the use of many collectors, the time required for the collector to combine with the ore must be taken into consideration. In stage addition, the collector is added as flotation proceeds in order to prevent an excess of collector at one time. In other cases all the collector is added at one time and it is given an opportunity to combine with the ore in an induction period.

The data of Table 1 illustrate results under stage addition. A comparison of Runs 34 and 36 shows the effect of rate. The faster rate of addition gives a greater percentage recovery at a higher copper concentration. The faster rate of addition does, however, require more collector.

The use of a conditioning period further increases the enrichment of the concentrate. A consideration of the value called successive enrichment is a guide to the performance. Successive enrichment is an approximate value expressing the ratio of percentage copper in the concentrate to that left in the pulp. The values for successive enrichment on Runs 36 and 12A, show that a much richer concentrate is obtained by the use of an induction period.

The amount of collector required per unit weight of chrysocolla is not specifically determined but an indication may be obtained from Runs 12A

Table 1 . . . Flotation results

No conditioning period; pH, 7.7 to 8.0

Experiment Number	Total Collector		Heads, Per Cent Copper	Total Time, Minutes	Successive Concentrate			Total Concentrate, Per Cent	
	Dye	Ton			Copper, Per Cent	Recovery, Per Cent	Enrichment	Copper	Recovery
32-a	Butyl	0.01	0.235	2	0.74	6.9	3.3	0.74	6.9
-b		0.02		4	0.65	4.2	3.0	0.70	11.1
-c		0.03		6	0.41	3.2	1.9	0.60	14.3
-d		0.04		8	0.51	2.7	2.4	0.59	17.0
-e		0.05		10	0.37	2.6	1.8	0.54	19.6
31-a	Hexyl	0.01	0.235	2	0.99	10.6	4.6	0.99	10.6
-b		0.02		4	1.18	12.4	6.2	1.08	23.0
-c		0.03		6	0.94	18.1	6.2	1.01	41.1
-d		0.04		8	0.33	8.4	2.3	0.75	49.5
-e		0.05		10	0.31	9.8	2.5	0.61	59.3
-f		0.06		12	0.06	1.6		0.50	60.9
34-a	Octyl	0.01	0.235	2	1.27	6.5	5.7	1.27	6.5
-b		0.02		4	1.39	12.1	7.1	1.35	18.6
-c		0.03		6	1.58	9.8	9.0	1.43	28.4
-d		0.04		8	1.46	9.4	9.4	1.43	37.8
-e		0.05		10	1.55	10.7	11.8	1.47	48.5
-f		0.06		12	1.44	4.5	11.9	1.46	53.0
36-a	Octyl	0.03	0.235	2	2.26	17.4	11.4	2.26	17.4
-b		0.06		4	2.64	17.4	16.4	2.4	34.8
-c		0.09		7	2.12	17.4	18.1	2.2	52.2
-d		0.12		10	1.27	11.8	14.1	2.0	64.0
-e		0.14		12	0.93	10.0	13.9	1.7	74.0
-f		0.17		14	0.37	2.5	6.1	1.54	76.5

and 18A of Table 2. With the richer head material containing 1.275 pct copper, 0.002 g of octyl malachite green gives a concentrate containing 0.525 g of copper (44.8 pct recovery). With a head material containing 0.235 pct copper and the same amount of collector, it gives a concentrate containing 0.161 g of copper (68.4 pct recovery). On the basis of the copper recovered, the leaner head material requires greater amounts of collector.

When an excess of collector is added, the solution remains colored and the sand is distinctly dyed. Both excess of collector and increased time in a weaker dye solution cause the flotation of sand. The regulation and restriction of the amount of free collector in the cell have an important influence on the recovery.

Comparing Runs 18A, 14A, and 21A in which the head materials contain 1.275 pct, 0.47 pct, and 0.235 pct copper, respectively, both successive enrichment and percentage recovery are seen to increase with the leaner ore.

Conclusions

1. These tests have illustrated the application of physical and chemical principles to the flotation process. The results on synthetic mixtures are not to be construed as equivalent to data on industrial mixtures.

2. Alkyl-substituted malachite green dyes act as collectors for chrysocolla in synthetic silica-chrysocolla mixture. The octyl-substituted malachite green is more effective than the lower substituted homologues.

3. The amount of collector used and the method of adding it have an important influence on the extent of recovery. Better results are obtained when a conditioning period is used. Better percentage recovery and enrichment are obtained with leaner mixtures. Optimum conditions of procedure have not been thoroughly studied.

4. Clay or material of a colloidal structure interferes with the separation.

5. The results suggest that the industrial separation of chrysocolla from a silica gangue may with modification be developed along these lines.

Appendix

A series of three alkyl-substituted malachite green dyes was synthesized. Butyl, hexyl, and octyl-hydrocarbon chains were substituted in the malachite green molecule. The structure of these compounds has been assumed on the basis of their properties as dyes, on their method of preparation, and on the intermediates used.

For the purpose of identification, these alkyl-substituted dyes are called: butyl-malachite green; hexyl-malachite green; and octyl-malachite green.

Recognized methods of preparation were used with such deviations as were necessary because of the nature of the intermediates and products. The high molecular weight of the compounds, with consequent high boiling points, made purification difficult. In many cases, a distillation pressure of 5 mm was not low enough to prevent serious decomposition. These difficulties were overcome but they frequently resulted in low yields. An outline of the general procedure is given.

Alkyl chlorides were formed by the method of Helferich and Schaefer[6] by the reaction of the normal alkyl acid with thionyl chloride.

The alkyl chlorides were then reacted with benzene in a Friedels-Craft reaction to form a ketone. The general procedure of Ju, Shen, and Wood[9] was used, but benzene was used as a diluent.

The alkyl phenyl ketone was reduced to the alkyl benzene by a Clemmensen reduction. A method developed by Johnson and Kohmann[10] and described by Martin[11] was used.

The p-alkyl benzaldehyde was formed from the alkyl benzene by Bouveault's method.[12] The procedure is outlined by Weygand.[13]

The leuco-base of the substituted malachite green dye was formed in a regular dye reaction with dimethyl aniline. It was oxidized to the dye with lead peroxide. The general procedure is outlined by Cain and Thorpe.[14] After purification, the products were found to be solids with the general characteristics and color of the parent dye. Overall yields on the basis of the alkyl benzene used, varied from 5 to 15 pct.

Table 2 . . . Flotation Results

Conditioning period, 3.5 min; pH, 7.7 to 8.0; collector, octyl malachite green

Run Number	Total Dye, Ton	Heads, Per Cent Copper	Total Time, Minutes	Successive Concentrate			Total Concentrate, Per Cent	
				Copper, Per Cent	Recovery, Per Cent	Enrichment	Copper	Recovery
18A-a	0.04	1.275	4.0	10.3	23.6	11.1	10.3	23.6
-b			6.0	9.6	9.1	11.7	10.0	32.7
-c			8.0	7.4	7.7	10.0	9.5	40.5
-d			10	6.6	4.2	9.6	9.2	44.8
-e	0.08		14	6.6	8.5	11.2	8.6	53.0
-f			16	5.7	5.5	11.0	8.25	58.6
21A-a	0.04	0.47	4.0	5.2	29.0	15.1	5.2	29.0
-b			8.0	5.3	9.3	17.7	5.25	38.3
-c	0.08		12	3.05	11.4	12.0	4.5	49.5
-d			14	2.66	14.2	14.5	3.9	63.5
14A-a	0.04	0.235	4	4.55	31.2	27.5	4.55	31.2
-b			6	3.9	13.8	29.5	4.35	45.1
-c	0.08		10	3.7	10.5	34.5	4.2	55.8
-d			12	1.3	7.7	14.9	3.4	63.5
-e			14	0.65	3.3	7.7	2.8	66.5
12A-a	0.04	0.235	4	3.75	34.7	24.0	3.75	34.7
-b			6	3.3	20.6	33.0	3.56	55.3
-c			8	2.2	5.1	22.7	3.4	60.5
-d			10	1.2	7.9	15.3	2.8	68.4

Acknowledgment

The experimental work was carried out as Project No. 65 of the Michigan State College Engineering Experiment Station. Supplies and equipment for the work were provided by the Engineering Experiment Station.

References

1. U. S. Bur. Mines: *R. I.* 3419.
2. U. S. Bur. Mines: *R. I.* 3357.
3. W. Suida: *Monat. Chemie* (1904) **25**, 1107.
4. E. Dittler: *Chem. Ind. Kolloide*, **5**, 93.
5. K. Endell: *Chem. Ind. Kolloide*, **5**, 244, 3.
6. B. Helferich and W. Schaefer: Organic Synthesis. J. B. Conant ed., 9, 32, 1929. New York, John Wiley and Sons.
7. B. Park: *Ind. and Eng. Chem.* Anal. Ed. (1931) **2**, 77.
8. W. Petersen: Schwimmaufbereitung. Dresden, 1936, Steinkopff, T.
9. T. Y. Ju, G. Shen and C. E. Wood: *Inst. Petr.* (1940) 514.
10. T. B. Johnson and E. F. Kohmann: *Jnl.* Amer. Chem. Soc. (1914) 36 1259.
11. E. E. Martin: Organic Reactions. Vol. 1, R. Adams, ed., 167. 1942. New York. John Wiley and Sons.
12. L. Bouveault: *Bull.* Soc. Chim. (1898) **15**, 1017.
13. C. Weygand: Organic Preparations. *Trans.* (1945). Interscience Publ. New York.
14. J. C. Cain and J. F. Thorpe: The Synthetic Dyestuffs and Intermediate Products. 1920. London. C. Griffin.

Recent Trends in Asbestos Mining and Milling Practice

By MICHAEL J. MESSEL,* Member AIME

Of the various minerals that occur in fibrous form known as asbestos, chrysotile is the variety most in demand for commercial uses, and, last year, over 683,000 tons of the various grades were produced in Canada and United States, exclusive of African and Russian production, which figures are uncertain. Production has not been able to keep up with the increased demand, and an acute shortage exists. Canada, Russia, and Africa are still the most important producers. However, Russia consumes most of its production at home and exports very little. The United States consumes over 60 pct of the total production and produces only about 4 pct of the total from deposits in Vermont and small quantities from Arizona.

This paper will review mainly, some of the more recent developments concerned with the extraction and processing of this fibrous mineral for various industrial uses, such as textiles, insulation, building materials and brake linings.

Four of the more important factors that have influenced recent developments are:

1. The lack of discovering and developing new deposits of any important size to supply the increased demand.

2. Rapid postwar expansion of industrial uses, especially in asbestos cement products, together with increased manufacturing facilities. European countries are again back on the market with their demand.

3. The ability of manufacturers to develop their technique of blending fibers and obtaining more utility value out of each ton of fiber, together with the utilization of shorter grades of fiber to obtain equally as good products. In the past, many manufacturers were wasteful in their use of fibers.

4. The struggle for reduced operating costs, in face of increased wages and prices of supplies, together with the necessity, at some mines, to change the method of mining from open quarry to underground.

Most of the recent capital invested in the asbestos mining industry has gone into more efficient extraction of the fibers from the existing ore, especially in the recovery of the shorter grades. There has been very little new plant expansion. Progress in the utilization of shorter fibers has been so far reaching that some of the mining companies are retreating present tailings as they leave the mill, and others are considering retreating of the old tailing dumps for recovery of fibers that, until recently, were not saleable and were discarded as part of the tailing. Many of these dumps contain much valuable fiber from days when milling was very inefficient.

It might be appropriate to mention here that the present known asbestos reserves of proved commercial value (excluding Russia) are being depleted at an alarmingly rapid rate, about 10,000,000 tons of ore is being mined annually. No new deposits have come into production during the last 15 years, with the exception of certain deposits in Africa, which are the most promising, and minor developments in Canada, Venezuela, Cyprus, Australia, and Brazil. The African deposits are the only ones that hold promise of developing large reserves. Unless new deposits are developed, in twenty years or maybe sooner, the supply picture will not be a very bright one. Stimulated by the acute shortage, increasing fiber prices and technical developments, many new areas are being prospected in Canada, United States, New Zealand, Newfoundland, South America, Europe, Africa, and China.

From information now available, it appears that no real progress has been made in duplicating this rare development of nature by producing synthetic asbestos. The most promising experiments were carried out at the University of Leipzig, but they seem far from practical. There has been marked progress in fiber glass manufacture, but so far, it has replaced asbestos only in very few instances for minor uses.

Asbestos ore and the fiber it yields are different in some respect at each mine and vary usually in the following:

1. Percentage of fiber content by weight to the gangue.

2. Variations in proportions of long and short fibers, some deposits being predominantly long fiber and others short fiber.

3. The hardness of the rock in which the fiber occurs.

4. The nature of the fiber, as to

New York Meeting, February 1948. TP 2536 H. Discussion (2 copies) may be sent to *Transactions* AIME before April 30, 1949. Manuscript received Feb. 26, 1948; revision received Nov. 29, 1949.

* General Superintendent, Vermont Asbestos Mines, Division of the Ruberoid Co., Hyde Park, Vt.

being harsh or crudy, difficult to open and fluff up, or easy to open. Asbestos fiber has never been opened to its maximum and each fiber bundle can still be further reduced into smaller fiber bundles. However, fibers are opened to a certain degree for various manufacturing purposes, and this opening should not go beyond such mechanical treatment as will result in the breakdown of fiber length.

5. The tensile strength of the fiber.

With all these variables involved in each deposit, and usually within the same deposit, the various developments at different mines have varied to some degree.

Review of Some of the More Important Developments

PROSPECTING AND LOCATING DEPOSITS

Discovery of most of the present important asbestos deposits has been purely accidental, and, in most instances, were made by farmers or wood cutters. By strange coincidence, these original discoveries of about 60 years ago are the most valuable and extensive deposits, most of which are still being worked today.

Geophysical methods have been used only with partial success. While certain electrical methods can outline fairly closely the extent of serpentine formations, which are favorable to the occurrence of asbestos, they give no indication of the presence of fiber or of its quantity. However, geophysical prospecting did show up extensive shearing in one deposit, a condition which is often favorable to occurrence of asbestos.

More careful methods of systematic core drilling and sampling are now used to get a more accurate appraisal of the deposit. However, samples of the fiber still must be obtained and tested in the laboratory and by actual manufacturing methods before it is certain that the fiber possesses the necessary characteristics to be of commercial value.

MINING METHODS

The conventional methods of mining are those ordinarily used in metal and nonmetal mines. In most cases, the deposits originally occurred as surface outcrops and open quarry methods were applied. In Canada, as the economic limits of quarrying were reached, the underground method of block caving was applied successfully and economically. This method has been described previously,[1] and some of the outstanding features of its application are as follows:

1. It can be successfully used in a slippery and highly sheared rock such as serpentine.

2. Concrete and steel should be used in place of wood for all underground supports and chutes.

3. At one mine, diamond drills have been used recently for undercutting the block, by drilling long holes and blasting, thus reducing the necessity of drifting.

4. Another company is considering the use of scrapers in the grizzly drifts, thus doing away with considerable expensive grizzly and chute work.

In Africa at one mine, a combination of shrinkage stoping and top slicing is applied to permit sorting of the ore in the stopes.

In quarrying, the current trend is to abandon drilling in a series of small benches, and to work benches up to 150 ft in height by means of blasthole drills, drilling holes 6⅝ in. diam spaced on 18 ft centers. At some mines, air drills mounted on derricks are used. At one location these drills are working a 90 ft face, drilling 70 ft holes with a 3½ in. starting bit, and a 2½ in. finishing bit. Supplemented with a row of holes at the base, large blasts are brought down successfully. With these high benches, blasts of 100,000 tons are not uncommon, and while some operators claim this has a tendency to destroy fiber length, it is probable that the economic advantages more than compensate for any such possible reduction.

[1] References are at the end of the paper.

FIG 1—Milled asbestos fiber.

For loading the ore, mechanical crawler type shovels of various sizes are used, the emphasis being on units which have a fast swing and easy maneuverability.

Haulage methods still vary considerably from one mine to another, depending on conditions. At one time, railways were used in nearly all quarries; the tendency now is towards truck haulage, with such units as Euclid trucks and Lynn tractors. At one mine, the use of belt conveyors and shuttle cars has been seriously considered.

CRUSHING, DRYING AND MILLING

Because of the rather low ratio of asbestos fiber to rock, an average of 5 to 6 pct, large tonnages of ore have to be milled in order to operate on a commercially successful basis. A capacity of 1000 tons per day is considered very small and usually the minimum unit.

Basically, there has been no change in the asbestos milling process, which still consists of primary crushing in two stages to reduce the ore to minus 1½ to 2 in., followed by drying the ore for removal of moisture to permit proper milling. The milling process consists of further crushing to release the fiber from the rock along cleavage planes, screening and aspirating the free fiber, followed by further fiberizing in specially designed machines which fluff up the fiber, and further screening and aspirating by air suction of the free fiber into cyclone separators. (Fig 1.)

This process is repeated in two or three stages, until all marketable fiber is removed and the remaining rock and fine sand is discarded as tailings. The collected fiber is then passed over screens for cleaning and removal of fine sand and unopened spicules of

fiber and rock particles. The clean fiber is then classified and graded according to length. There are about 25 grades depending on the proportion of the various length of fibers.

Fiber is still valued and sold according to length as determined on a standard Quebec testing machine, though some mines have their own standard and do not follow the Canadian practice. While preservation of length is still important in milling, more emphasis is now being given to efficient extraction of every marketable pound of fiber. Demand has carried this to the point where some of the shorter grades, known as asbestos sand, now contain up to 50 pct, or more, of granular rock particles. This grade is blended with other short grades for the manufacture of asbestos floor tile.

Drying

For drying the ore, (which contains from 1 up to 20 pct moisture), no new types of dryers have been developed. Either the vertical stack type or the rotary dryer is used. More attention is being given at present to insulation and to more efficient use of fuel. The relative efficiency of the drier is now about 50 pct, whereas not long ago 30 pct was considered good. For efficient milling the rock must be dried to 1 pct moisture or less. The dried rock is then stored in large silos or bins. These silos are usually constructed of tailing material which forms natural banks with sloping sides in the form of a hopper that is covered with a structure at the top of which is located a feed conveyor. At the bottom, there is a concrete tunnel with draw points. Silos up to 60,000 tons in capacity have been constructed in this manner at a cost of around $5 to $6 per ton of storage. Such silos are economical in construction and permit large storage of dry ore for more effective curing, and also for blending of the ore to attain a more even and constant mill feed. The use of surge piles of ore at various points in the process, from quarry to mill, makes operation more efficient and has been very successfully applied at one mine. These piles require no covering and material is drawn out below through a concrete tunnel equipped with draw points.

Milling

Milling is a dry process. In each ton of ore the fiber length may range from 1½ to 1/16 in., so no fixed flowsheet is possible, as the flowsheet must be adjustable to meet varying conditions. Certain grades of fiber demand special equipment.

The four factors that can be partially controlled in milling are:

1. The efficiency of the extraction.
2. Maintaining the length of fiber as it originally comes from the deposit.
3. The degree of opening or fluffing of the fibers.
4. The amount of "drops" (−35 mesh) and granular dust remaining in the finished fiber.

Fine Crushing and Fiberizing

The use of Symons Shorthead cone crushers set to as fine as 1/8 in. is finding a place in nearly every flowsheet. The advantage of this equipment is that it frees the fiber from the rock by crushing it along the plane of weakness without destroying the fiber length. It also produces a harsh primary fiber which is practical for some uses. The crushing also prepares the rock particles for the operation following screening and aspirating, that is, for fiberizing or fluffing of the fiber, together with freeing more fiber and making it amenable to air suction.

Three types of machines have been developed for freeing fiber from rock, and while somewhat similar in principle they may give widely different results on the same ore. The principle of these machines is that of a hammer mill, which by means of rotating hammers, strikes or throws the particles against corrugated plates or jaws, the impact and attrition causing the fibers to open and fluff.

These machines are the Jumbo, Torrey Cyclone, and Impact Mill.

The Jumbo consists of a horizontal steel shell, 36 in. diam by 72 in. long, lined with corrugated liners, in which is mounted a shaft that has steel arms with beater tips attached. This shaft rotates at 600 rpm. The material enters at the top on one end and is discharged at the bottom of the other. This Jumbo, while efficient, has a tendency to cut up and grind the fiber. The present trend is now to replace it with a combination of crushers and vertical type mills.

The Torrey Cyclone and Impact Mill consist of a steel shell, approximately 4 to 5 ft diam by 5 ft high. The shell is lined with corrugated manganese plates or jaws. In the center is a rotating shaft to which the beater arms are attached. This shaft rotates at 900 to 1000 rpm.

The Torrey has two sets of hammers separated by an intermediate hopper. The material entering at the top is thrown by the centrifugal force of the hammers against the jaws. The material is then guided toward the center and the action is repeated by the next set of hammers.

The fiberizing in this instance is done by impact against steel jaws, though there must be some disintegrating action by inertia. The fundamental difference between the Torrey and the Impact Mill, is that in the Impact the intermediate hopper is eliminated; the material falls freely by gravity and is struck by the revolving hammers. Disintegration takes place predominantly by simple inertia.

Neither of these machines is ideal, both have a tendency to cut up some fiber and create rock dust. Mechanically, the Impact is superior but requires more power per ton of material fiberized. A more efficient machine may be a modified combination of the two, and this is now being developed.

Screening

Screening is very important in asbestos milling and it occupies about 60 pct of the total floor space in a mill. It is important to recognize that the fundamental functions of the various screens change from one end of the flow to the other.

At the beginning, in the rock flow, the primary function is some separation and removal of sand, but fundamentally it is to form an even layer of ore so that the fluffed up fiber particles may be aspirated by air.

For treating the collected fiber, the screen function is removal of dust and fine sand, and formation of a bed to facilitate aspirating the fiber by selective air so that unopened particles of fiber and rock will not be lifted but returned to the primary rock flow or special circuit for further fiberizing.

The function of screening of cleaned fiber is to separate the various lengths of fiber.

Two main types of screens are used. The reciprocating type actuated by an eccentric is known as a shaking screen, the usual size is 5 by 10 ft, and speeds range from 200 to 450 rpm. The other type is one with a gyratory motion, actuated by a vertical eccentric head. At one time, only shaking screens were used in the industry, and many mills still retain the practice, but some mills have gone exclusively to the gyratory type. There have been very

marked improvements mechanically on both types of screens.

One type of gyratory screen is claimed to have about twice the capacity as compared to the shaking screens, but this is in some instances only, depending on the objective. However, there is little doubt that the gyratory screens are considerably more efficient in the fiber cleaning and classification circuits.

Fiber Collectors and Air Systems

Asbestos mills are still a maze of air pipes, cyclone collectors and fans, which are used for aspirating and collecting the fiber. The principle of separating fiber from rock depends on a fan-created vacuum in the collectors. The resultant air suction lifts the fiber off the screens through the hoods and piping to the collector. About 1 to 2 in. vacuum is required on the rock screens and ½ to 1 in. on the fiber screens. Only developments of a minor nature have taken place here, such as, more efficient collectors, improved piping layouts, and more efficient fan blades. About 5000 cfm is required per screen, and air is such an important item in the process that it takes about 20 to 25 pct of the total horsepower used in the mill operation.

Grading and Classification of Fibers

After the fiber is cleaned, it is usually already partly classified and the final adjustments for standard test are made by using screens, or, more frequently, by the rotary type graders. The different mines have developed various types and sizes of their own. Basically, this unit consists of an enclosed trommel of perforated plate which may or may not rotate, and has a central shaft with beater arms which are inclined in the direction of the flow. The materials enter at the top of one end and are forced across to the other end by the beaters. The shorter fibers are forced out through the screen openings, and longer ones are carried through and discharged at the end. Various size openings may be used in the same trommel to give different size products. A standard machine now frequently used is 28 in. diam by 10 ft long, and rotates anywhere from 200 to 500 rpm. The capacity of these units is usually 1 to 2 tons per hour for long fibers and 4 to 5 tons on the shorter grades. The resulting products from these graders are blended to obtain the desired test and specifications.

Dust Collecting

In asbestos milling, which is a dry process, considerable dust is created in the various operations, together with a large amount contained in the air from the fan exhausts, as the fiber collector is really only a partially efficient separator. Some shorter fibers escape into the fan, and these, if recovered, have commercial value.

In the past, this air has usually been sent through ducts to a large settling chamber, where the heavier material is dropped because of reduced velocity, and returned to a special circuit or department in the mill flow. At the end of the dust building, there is a chimney for the exhaust dust. In one instance where this dust has been objectionable, one company has installed a Cotrell system.

However, a recent successful development has been the application of bag type collectors with automatic shaking devices which usually can be made to fit very nicely into the top of the conventional mill building. These units not only recover the valuable fiber, but also the dust, so there is a very small amount of exhaust dust in the atmosphere. Some companies are experimenting with the possibilities of recirculating this air. About 98 pct efficiency by weight is claimed for these units, and at present, there are many installations under way. The cost is approximately 20 cents per cubic foot of air, and about 1 sq ft of filter cloth is necessary for filtering 3 cu ft of air.

Tailings Treatment

Mill efficiency is usually based on fiber recovery, as compared to weight of the rock. This is not based on the original fiber present in the ore, as there is no accurate way to determine this, but on the pounds of marketable fiber that can be recovered from a ton of ore. Therefore, the term "fiber content" varies with conditions, and in the past, due in part to inefficient milling and the non-marketable shorter fibers, many tons of now valuable fiber reached the dumps.

Due to the demand for shorter fibers, some mills have installed Whizzer type air separators or other modified types of air separators on their tailings, rather than adjust or modify the existing flowsheet.

At one mine, a plant is now being constructed to retreat the old tailings dumps by a wet method. The tailings, as they come from the dump, are screened and the plus 5/16 in. is discarded as of no value. The minus material is sent to cone type classifiers, where the fiber is floated off in water and sent to filters. Later, it is removed, dried and fluffed up, and a clean commercial fiber results.

Bagging of Fiber

Asbestos fiber, when processed, becomes bulky and difficult to handle. The various grades of fiber are packed either by hand or machine, but more usually by plunger type bagging machines, in 100 pound lots, into either jute or paper bags.

The bagging machines, used at present by the various companies, are rather cumbersome, and there is certainly plenty of room for improvement here. Bags alone, today, cost about $4 to $6 per ton of fiber.

If some method of compressing and bailing, or bulk shipment, could be worked out, it would mean considerable saving to the industry.

Summary

Development of the present method of extracting and milling asbestos fibers has taken many years of practice, and the ingenuity of many capable men, to achieve the refinements and controls available today in producing fibers for manufacturing requirements to standard specifications.

In the asbestos milling and manufacturing industry, there are so many variable factors involved, that it is easier to claim progress than to prove it. However, the trend is toward more efficient equipment and more efficient utilization of the fibers. In general, there is a very cooperative spirit between the various companies which should result in very marked progress for the future.

References

1. J. G. Ross and Staff: Block Caving at the King Mine of the Asbestos Corporation, Thetford Mines, Quebec. Canadian Inst. of Mining and Met. (1934) 184–218.
2. Caving at Johnson's Asbestos Mine. By the staff. Canadian Inst. of Mining and Met. (1941) 453–477.
3. Operating the World's Largest Asbestos Mine. *Eng. and Min. Jnl.* (Sept. 1941) 43–47; (Oct. 1941) 49–53; (Nov. 1941) 51–56.
4. Oliver Bowles: The Silk of the Mineral Kingdom. Ruberoid Co., 1946.

A Technical Study of Coal Drying

By G. A. VISSAC,* Member AIME

Moisture in Coal

MOISTURE in coal must be considered as an impurity, just the same as ash, from the standpoint of utilization of the coal. Being incombustible, it reduces directly the heating value of the coal, and in addition absorbs heat for its evaporation. Its presence means useless expenditures in handling and transportation. In coke plants, extra moisture reduces capacity and may cause damage to brick work and equipment.

Accordingly, the removal of extra moisture can be considered just as important as the removal of other impurities, such as ashes, in the modern coal preparation plant.

Moisture, which can be removed by heating the coal up to a temperature of 100°C, may be retained in various forms:

1. As a film, on the surface of each coal particle, and in the interstices between particles, retained by capillary forces.
2. Or "occluded" inside the coal particles. This occluded moisture may be either free moisture (as in a sponge), or hygroscopic moisture which varies with atmospheric conditions, (also called "regain").

These latter forms of moisture are particularly common in "young" coals (subbituminous and lignites); bloom coals (seam outcrops); fusain; and carbonized products.

In our study of coal drying, we shall consider only the removal of free moisture, exclusive from hygroscopic moisture.

Dewatering

If we reserve the name of drying to the removal of water by evaporation, we must consider the initial phase of the mechanical removal of free moisture as a distinct operation covered by the term dewatering.

In all cases the free water carried over the surface of the coal particles or in their interstices, or in their pores, is retained by capillary forces. Dewatering is accomplished by breaking or counteracting these capillary forces; removal of as much water as possible by dewatering methods is usually advisable, as the cost of these operations is generally much less than by evaporation.

The most common methods of mechanical dewatering are:

1. "Pressure piling," which reduces the interstitial spaces, accomplished in dewatering bins or over dewatering screens.
2. Or dynamic methods, such as used in centrifuges or over vibrating screens.

We shall only mention the "preferential wetting" method, in which surface water can be displaced by hydrocarbons, as offering possibilities, but which, to our knowledge, has not reached yet a practical development.

But we must point out that the capillary forces retaining water on the coal surfaces, decrease considerably with increased temperatures. This is the principle used in all modern dishwashing machines; by using very hot water, dishes are extracted almost dry.

In line with this development, we favor the type of dryers including a dewatering section; as the coal enters the dryer and is gradually brought up to higher temperatures, its dewatering ability is increased and advantage can be taken of this conditioning, resulting in increased drying efficiencies and reductions in drying costs.

Heat Drying

In the final phase, the remaining moisture must be evaporated. Coal and water must be brought up to the chosen temperature of evaporation, and heat must be supplied to fill the requirements of the latent heat of evaporation of the water to be removed.

Accordingly, drying becomes largely a problem of heat transfer, and drying methods can be classified accordingly, namely:

1. Radiant transfer.
2. Transfer by surface contact and conduction.
3. Transfer by hot gas contact.

The first method is not applicable to coal drying; the second method is used in the old type rotary dryer. The third method, the most commonly used in modern coal dryers, will be the only one considered here; and, of course, we shall deal with continuous types of dryers only.

The mechanism of complete drying is really very complex—several phases are involved:

1. The constant rate period.
2. The uniform falling rate period.
3. The varying falling rate period.

As most of our practical coal drying problems deal with wet coals (over 6 pct of moisture), and do not require complete drying (under 1.5 pct), we shall deal with the first condition only, namely the *constant rate drying.*

Dryer Calculations

Instead of presenting the algebraic formulas, we believe a concrete example will provide a clearer illustration.

Assume a feed of wet coal at the rate

San Francisco Meeting, February 1949.

TP 2537 F. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before May 31, 1949.

* Consulting Engineer, Vancouver, B. C.

of 60 tons per hour with a free moisture content of 12 pct; it is required to bring the free moisture content down to 2 pct.

We assume our dryer will remove mechanically 5 pct of moisture, leaving 5 pct to be removed by heat drying.

VOLUME OF GASES REQUIRED

(Summer conditions 60°F.)

A feed of 60 tons per hour is 1 ton, or 2000 lb per minute.

The moisture to remove is 5 pct of 2000, or 100 lb per minute (dry basis).

Assume evaporation at 120°F (temperature of gases at dryer's exhaust) and 60°F as outside temperature.

1 cfm of air carries:

at 120°F and at
full saturation 0.005 lb water per cfm
and at 60°F 0.001

a difference of 0.004

And if we assume a 75 pct evaporation,
1 cfm of hot gases will remove 0.003 lb of water

Accordingly, the air required on the basis of evaporation alone is: 100/0.003 or 33,333 cfm (measured at sea level, and 70°F).

TEMPERATURE REQUIRED FOR HOT GASES

If we call T this temperature,
$33{,}333 \times 0.073 \times 0.25 \times (T - 120)$
will give us the number of Btu's available, when 33,333 cfm of gases — density = 0.073, sp. heat = 0.25, cool off from T, down to 120°F (temperature of evaporation).

This amount of heat per minute must be sufficient to:

1. Evaporate 100 lb of water at 120°F
(latent heat = 1024),

or

$100 \times 1024 = 102{,}400$ Btu

2. Heat coal and water from 60° to 120°; namely:

Coal: $2000 \times 0.25 \times (120 - 60)$
Plus water: $100 \times 1 \times (120 - 60) = 36{,}000$ Btu
(sp. heat of coal = 0.25)

3. Take care of radiation losses:

On the basis of a dryer with 2000 sq ft of insulated surface and 2000 sq ft of exposed surface, we have -

2000 sq ft at $0.2\ (T - 60)$
plus 2000 sq ft at $2.5\ (T - 60)$ per hour
(60 being the outside temperature)
or per minute: $90T - 5400$ Btu

The equation of heat balance is then:
$33{,}333 \times 0.073 \times 0.25 \times (T - 120)$
$= 102{,}400 + 36{,}000 + 90\ T - 5400$
or $T = 400°$F (approximately).

TOTAL HEAT REQUIRED

As per the above, the heat required is total of (1), (2) and (3), namely
169,000 Btu's per minute, or roughly, 10,000,000 Btu's per hour.

WINTER CONDITIONS

(Outside temperature 0°F.)
Evaporation at 110°F.

Volume required:
Lb of water per cu ft at 110°F = 0.00376
Lb of water per cu ft at 0°F = 0.00006

0.00370

At 75 pct evaporation —
1 cu ft will remove 0.00278
and for 100 lb per minute we require
100/0.00278 = 36,000 cfm
(measured at sea level and 70°F).

Hot Gases Temperature

T given by equation:
$36{,}000 \times 0.073 \times \frac{1}{4}\ (T - 110)$
$= 100 \times 1020 \times 2000 \times \frac{1}{4} \times (110 - 0)$
$+ 100 \times 1 \times (120 - 0)$
$+ 2000 \times 0.2\ (T - 40) \times \frac{1}{60}$
$+ 2000 \times 2.5\ (T - 40) \times \frac{1}{60}$
or $657\ (T - 110) = 165{,}400 + 90\ T$
or $T = 418°$F.

Total Heat Required

200,000 Btu per minute
or 12,000,000 per hour.

FURNACE REQUIRED

Total heat required = 170,000 Btu's per minute.
or with coal at 12,600 Btu and at 75 pct combustion efficiency
170,000/0.75 × 12,600
or 18 lb of fuel per minute
or 1080 lb per hour
at 42 lb per sq ft.

The required grate area is 26 sq ft.

Combustion space at 50,000 Btu per cu ft per hour required
= 200 cu ft or 7.7 arch.*

DRYER FAN

Volume required = 33,333 cfm at 70° at sea level
or 33,333/0.858 = 40,000 cfm at 70° at 4000 ft.

water gauge 4 in. at 70° at sea level
or 4/0.858 = 4.66 in. 70° at 4000 ft.

Power required:

$$\frac{(40/33)^3 \times 0.858 \times 0.000157 \times 33{,}333 \times 4}{0.65}$$

or 49.5 hp

BLOWER FAN AT FURNACE

Required 15,000 cfm (equal to volume hot gas in furnace)
Water gauge = 1 in.

COLD AIR DUCTS

Required 18,000 cfm of cold air (see furnace calculations).

HOT GASES DUCTS

Volume at 70°F sea level is 33,333 cfm at 400°F at 4000 ft elevation volume is:
33,333/0.858 × 0.616 = 63,000 cfm.
Desired speed about 2000 fpm.
Section required about 30 sq ft.
Proposed area 5 × 6 ft.

Influence of Hot Gas Temperature

The Table 1 illustrates the effect and consequences of a change in the hot gas temperatures.

In Table 1 we have condensed the operating data corresponding to two different hot gas temperatures. Increasing the hot gas temperature from 400° to 660°F, reduces the required volume from 34,000 cfm down to 18,800 cfm, and the fan consumption of power from 38.50 kw-hr down to 20.25 kw-hr, but the Btu's required are increased by 2,000,000 Btu per hour.

However, this is based on the assumption that proper arrangements are made to maintain the water gauge constant (in our case equal to 6.35 in.). But if we had to use the same size of ducts and the same coal bed resistance, in Operation No. 1, the water gauge would be increased by 1.5 and the required kilowatt hours by 2.25, to 86.60 kw-hr, an increase of 66.6 kw-hr over Operation No. 2.

Assuming a ten hour day operation, and taking this most unfavorable condition for Operation No. 1, the final balance will be:

Condition No. 1 uses 666 kw-hr more per day (10 hr), or at 0.005 cents per kw-hr, an excess cost of $3.33 per day, but uses one ton of coal less per day, which may be worth the same value.

* Combustion here at 300 pct excess air, giving: 15,000 cfm hot gases and besides 18,000 cfm of cooling air are added, giving the required total of 33,000 cfm at the dryer.

Table 1 . . . Dryers Operating Data for Two Different Hot Gas Temperatures

	Operation 1	Operation 2
Temperature of evaporation	120°F	140°F
Volume of hot gases	34,000 cfm	18,800 cfm
Temperature of hot gases	400°F	660°F
British Thermal Units required:		
Evaporation (100 lb)	102,400 Btu	101,300 Btu
Heating water and coal	36,000 Btu	48,000 Btu
Radiation losses	30,600 Btu	54,000 Btu
Total per minute	169,000 Btu	203,000 Btu
Total per hour	10,140,000 Btu	12,198,000 Btu
Horsepower required for dryer fan	50 hp	27 hp
Kilowatt hour	38.50	20.25

Normally, with a dryer adapted to take care of the increased volume, that is, the same water gauge, the operating balance is definitely in favor of the low temperature, namely:

1. Operation No. 1, an increased power consumption of 18.50 kw-hr, or 185 in a 10 hr day, or 0.92 cents per day.

2. Operation No. 2, an increased coal consumption of 1 ton per day, worth between $3.00 and $3.50.

In order to give a wider picture of the influence of the hot gas temperatures, we have worked out in Table 2 the corresponding volumes and temperatures with temperatures of evaporation from 110° to 145°F.

Table 2 . . . Required to Evaporate One Pound of Moisture per Minute

V—Volumes of hot gases required, measured at 60°F and sea level.
T—Temperature of hot gases at duct in Fahrenheit, corresponding to various temperatures of evaporation.

Temperature of evaporation, degrees F	110	115	120	125	130	135	140	145
V, cfm	495	405	340	289	251	220	188	167
T, degrees F	300	350	400	460	520	580	660	750

Rate of Evaporation

QUANTITY

The rate of evaporation is given by the formula:

$$W = C \times V^{0.8} \times (e_w - e_a)$$

where:

W is pounds of water evaporated per square foot per hour.

V is velocity of hot gases in feet per minute.

e_w is vapor pressure in inches of mercury at water temperature.

e_a is vapor pressure in inches of mercury in atmosphere.

C is a constant characteristic.

The above formula illustrates again the influence of the factors involved. A higher temperature of evaporation means a higher value for e_w, but a lower volume of gases and a lower value of V.

TIME

If Q is the heat energy conducted in time t, through a material of sectional area A, normal to the flow of heat and of thickness D in the direction of the flow of heat, with a temperature difference T between its surfaces, Q is given by the formula:

$$Q = K \times \frac{ATt}{D}.$$

K is a constant characteristic.

or

$$t = \frac{QD}{KAT}$$

In other words, the time necessary to the required heat exchanges is reduced by the use of higher temperatures, factor T, but this is partly compensated by the increased heat energy required, Q.

But the above formula clearly indicates the advantage of a large area, A, in reducing the time required to the heat exchanges.

Cooling and Regeneration

As the dry coal and the exhaust gases leave the dryer at a higher temperature than when they were introduced, we shall lose a certain amount of Btu's. In order to increase the dryer's efficiency we must endeavor to recuperate and regenerate the maximum possible amount of these Btu's carried away by the dry coal and the exhaust gases.

The best practical methods in our experience are as follows:

1. Blow some cold air over the coal coming out of the dryer

2. Spray water in the dryer's exhaust.

COOLING OFF THE COAL

In fact this cooling off will be used to evaporate a certain amount of the water remaining in the coal. If the coal is cooled off from 120°F, down to 70°F, the amount of Btu's liberated at the rate of 2000 lb of coal per minute are:

$$2000 \times 0.25 \times (120 - 70) = 25{,}000 \text{ Btu}$$

If we use this amount of heat to accomplish an extra amount of drying, if p is the extra weight of moisture evaporated per minute, and V the volume of cold air originally at 30°F and heated to 80°F, we have the equation:

$$V \times 0.08 \times (80 - 30) \times 0.25 + p \times 1000 = 25{,}000$$

Saturation at 80°F is 0.0013 lb per cu ft.
Saturation at 32°F is 0.0003 lb per cu ft.
a difference of 0.001 lb per cu ft.

We can admit that every cubic foot will evaporate 0.001 lb of moisture, then

$$0.001 \times V = p$$

Solving the above equations gives us:

$$V = 12{,}500 \text{ cu ft per minute}$$
$$p = 12.5 \text{ lb of water}$$

or, on the basis of 2000 lb of coal per minute, an additional drying of over half of one per cent, made available without additional heat.

The corresponding increased consumption of power will be about 5 kw per hour,
or, on a 10 hr shift, 50 kw-hr
or, 0.25 cents per day (at half a cent per kw-hr).

The saving in coal consumption at the furnace on the basis of a 50 pct efficiency will be

2 lb per minute
or 120 lb per hour
or 1200 lb per day.

REGENERATION

The cooling off by water of the exhaust gases from say 120°F down to 60°F will recover, with a volume of 35,000 cu ft at 0.06 lb per cu ft.

$$35{,}000 \times 0.06 \times 0.25 \times (120 - 60) = 31{,}500 \text{ Btu}$$

The circulating water of a washery operating in a closed circuit is used for this purpose; this regenerated heat is used to preheat the coal before it is fed to the dryer.

In addition to their technical value, cooling and regeneration offer many material advantages:

1. Cooling reduces the danger of spontaneous combustion, decreases sweating of loaded coal.

2. Regeneration assists in the heating of the preparation plant, the thawing of frozen coal, and its mechanical dewatering (by reducing surface tensions).

Analysis of Results
Measures of Efficiency

The efficiency of a heat dryer is equal to the quotient of the heat actually used for evaporation, by the total heat supplied.

Example: (refer to Table 1, Operation No. 1, hot gases at 400°F)

Heat used for evaporation
102,400 Btu per minute

Total heat required by dryer
169,000 Btu per minute

Efficiency: 60 pct (approximately)

Operation No. 2 (hot gases at 660°F)

Heat used for evaporation
101,300 Btu per minute

Total heat required by dryer
203,000 Btu per minute

Efficiency: 50 pct

This is another illustration of the advantage of operating at low temperatures.

The total efficiency of a drying plant is the quotient of the Btu's actually used for evaporation, by the Btu's actually supplied to the furnace, or

Operation No. 1
$0.60 \times 0.75 = 45.0$ pct

Operation No. 2
$0.50 \times 0.75 = 37.5$ pct

Cooling and regeneration will increase the above efficiencies as follows:

Operation No. 1: The theoretical heat required to evaporate

5 pct by the dryer
0.5 pct by cooling

would require for the system—
$102{,}400 + 10{,}240 = 112{,}640$ Btu's

As previously indicated,

the total heat required is	169,000 Btu's
Less, recovered by regeneration	31,500 Btu's
or	137,500 Btu's

The actual dryer's efficiency is increased from 60 pct up to

112,640/137,500, or 82 pct

For a true comparison between the various drying devices, other factors must be taken into consideration.

Referring to our dryer calculations, we have estimated at 75 pct the saturation of the exhausted gases in the dryer. This is an actual minimum, obtained by experience, and which applies to most dryers. However, in actual practice this figure may have to be checked; a lower saturation will indicate lack of sufficient contact between coal and gases, because of a faulty design or a faulty operation.

From the above discussion it appears desirable to operate a coal dryer at low temperatures, in order to obtain not only the maximum efficiency, but also the best safety of operation; in this connection, it will be important to keep in mind the following kindling temperatures:

	Degrees F
Bituminous coal	600
Bituminous slack	500
Anthracite dust	570
Lignite dust	240
Anthracite slack	750
Lignite slack	435

(with slight variations between fields)

However, in order to operate at low temperatures and still handle large tonnages of coal, a coal dryer must be able to handle large volumes of gases, and special mechanical devices will be required to that effect.

Another frequent advantage of the operation of a dryer at low temperatures is in the possibility of using the exhaust gases available from existing boiler plants, or carbonization plants.

Generally speaking, all dryers can be adapted to dry fine coals; the mechanical problems involved can always be solved, because, after all, it will always be possible to obtain the necessary spreading or dissemination of the coal to ensure the desired contacts between all coal particles and the hot gases. However, the best mechanical solutions will give the best safety of operation, and the largest capacity per area or volume of machine.

But differential types of dryers only are adapted to the drying of a wide size ratio of feed. The largest sizes of coals (stoker, stove, and so on) require careful handling to avoid degradation, but as we all know, they do carry a smaller proportion of moisture and require less drying time than the small sizes.

Drying Characteristics

Before the proper layouts and selection of equipment can be made, we must first of all determine the drying characteristics of the coal to be treated; in other words, establish the relative drying difficulties of the coals or sizes of coals to be treated.

These preliminary studies can be done easily even in the most elementary laboratory. Our method consists in plotting the drying curves of the tested coal, just as washing curves are established for a coal cleaning problem.

Drainage factors are established first; the coal fully saturated with water is allowed to drain over a certain period of time. If, for instance, a certain size of coal is drained down to 6 pct in one hour, its drainage factor will be 1; if a slack coal is drained down to 10 pct in 12 hr, the drainage factor will be 12. In each case the final moisture contents considered are based on practical experience, coal characteristics, and actual requirements.

Drying factors are established in the same manner; coals are allowed to dry in a heated laboratory under certain constant conditions of evaporation. If it takes 3 hr to dry a certain size from its final point of drainage, say 5 pct moisture, to the required point of drying, say 2 pct, the drying factor of this coal will be 3.

If it takes 20 hr to dry a certain slack from say 10 pct of moisture, down to 2.5 pct of moisture, the drying factor of this coal will be 20. It must be well understood that this drying factor is controlled by a combination of the coal and size characteristics as well as by the particular requirements of our individual drying problem.

As an illustration the same slack as illustrated above, but with a required drying down from the same 10 pct, to say 5 pct (instead of 2.5 pct), may have a drying difficulty of 10 instead of 20; which illustrates the well known increased difficulty of drying the last 1 pct of moisture.

On the basis of such information, and of the comparative knowledge of his dryer, the drying engineer will then be able to determine all the factors required for a proper design of the complete drying plant; from the "drying characteristics" of the sizes of coal to be dried within definite moisture contents, he will deduct the "time element" of each individual problem; and by proper reference, he will be able to determine the number, sizes, and capacities of the driers required.

General Engineering of a Coal Drying Plant

The preliminary planning of a coal drying plant is a most essential part in the general planning of the whole coal preparation plant; in some cases it may be the dominating factor in the selection of the cleaning methods and apparatus.

We may, for instance, have to deal with a very slacky raw coal, with a free moisture content between 4 and 5 pct. This coal is easy to clean and could be handled satisfactorily over air tables if dried down 2 or 2.5 pct; cleaned by a wet process, this coal will dewater down to 18 pct; mechanical dryers or drainage bins will reduce the moisture down to 12 pct, and a very elaborate heat drying will be required for its final drying down to 2 or 3 pct.

Obviously, predrying followed by dry cleaning will be the cheapest solution and unless heat drying is to follow the wet process, dry cleaning may result in a higher value coal. For instance, a final product at say 8 pct ash and 2 pct moisture, total impurities 10 pct, is a better value than the same coal at 6 pct ash and 6 pct moisture. Furthermore, in Canada and some of the northern states, coal with a free moisture content of 6 pct will freeze solid in the winter time.

When considering a wet process, the determining factor in the choice of the apparatus to be selected and of the flowsheet to be adopted, is the true relationship between ash and specific gravity over the whole range of sizes.

Coals with wide "dispersions" are less suited to "bulk washing;" better results will be attained in their case with a flowsheet providing for presizing, followed by washing in small independent units.

As an illustration, a size density analysis of a well known coal from the LaSalle County, Ill.,* is given in Table 3.

Table 3 . . . Size Density Analysis Mine A, Coal No. 5
Gravities 1.30 to 1.35

Sizes, Inches	Weight, Per Cent	Ash, Per Cent
5 to 3	17.90	15.55
3 to 1.5	26.70	12.45
1.5 to ¾	16.15	13.36
¾ to ¼	25.40	10.75
¼ to ⅛	32.54	8.62
⅛ to 0	27.70	5.80

These gravities are obviously an important part of this coal, an average of 25 pct; still the same gravities indicate variations in ash content of from 5.80 to 15.55 pct. Many coals in Alabama, Washington, and Canada indicate a still wider dispersion.

This short discussion indicates that the drying and cleaning characteristics of the coal to be treated must be taken into equal consideration when making the preliminary investigation for a coal preparation plant.

Practical Conclusions

As a conclusion, our drying problem may be essentially:

1. Predrying of the raw coal in conjunction with a dry cleaning process:
Or, following a wet process:

2. drying of bulk coal,
or

3. drying of presized coal,
and a fourth solution, common in Europe will be

4. predrying of the raw coal, to allow efficient dedusting, followed by:

   a. wet processing of the dedusted coal

   b. drying of the processed coal.

The present systems for the cleaning of fine coals are still inefficient, the drying of the fines is difficult and expensive; dedusting of raw coal will result in savings and improved final results.

The next step will be the selection of dryers, their number, and their general arrangement.

We hope the technical discussions of our preceding paragraphs may help for a better understanding of the problems involved, and of the solutions required.

Generally speaking, most dryers can be mechanically adapted to the drying of fine coals; but their efficiency will depend on their ability to ensure the best possible contact between coal and hot gases (only type of dryer considered), and on that basis, the dryer capable of operation at the lowest temperature will be the safest and most efficient to operate. But its initial cost may be higher because of the necessity of using larger fans to handle the correspondingly larger volumes of gases required.

Predrying of bulk raw coal to condition it for a dry cleaning plant, or for preliminary dedusting, will require special types of dryers to minimize degradation.

Drying of wet treated bulk coal will require a selective type of dryer; as an illustration, in the same feed the large sizes have a difficulty equal to 5, the small sizes a difficulty equal to 20, and unless the dryer is adapted to retain the small sizes four times longer than the large sizes, the drying will not be uniform and may prove entirely inadequate. In this case also the mechanical features of the dryer must avoid degradation.

Drying of sized coal will be the easiest problem, but unless we deal with a large capacity plant, it may require too many small capacity units, at an excessive initial cost of installation.

In all cases where substantial outputs are required, dryers with the largest unit capacity will be cheaper to install and to operate. The cost of the dryer itself may be from 10 to 20 pct of the total cost of the drying plant; the more dryers, the more conveyors, elevators, fans, and so on.

Finally, in some cases, the proposed drying plant may be located in the vicinity of a steam plant, coke ovens, or some heat process plant, disposing of wasted gases at temperatures between, say, 250° and 350°; obviously in that case a dryer capable of operation at such low temperatures will be the most desirable solution.

General Conclusions

We have endeavored to restrict this paper purely to technical discussions of the problems involved in coal drying, and to an exposé of some of the practical methods we have evolved in this connection in the course of 40 years of work in Europe, Canada and the United States.

Coal drying is still relatively a new art in this country, but its importance is growing as the cleaning of the fine sizes of coal is progressing and taking a larger importance.

Acknowledgment

We wish to express here our appreciation for one of the first material contributions recently published by the AIME, namely "The Thermal Drying of Fine Coals," by Orville R. Lyons, Research Engineer, and A. C. Richardson, Supervisor, Battelle Memorial Institute, Columbus Ohio. We believe this valuable work sponsored by Bituminous Coal Research, Inc. has opened the road to a true scientific approach of the subject, and should result in further efficient developments; in the above paper we have only endeavored to bring our personal contribution.

* From University of Illinois *Bull.* 217, 28 (13) (Nov. 25, 1930).

Tunneling in rock by fire setting was first described about the 2nd Century B. C. and was still used in England in the 18th Century, even though gunpowder for blasting rock started in Chemnitz, Germany, in 1627.

Mining—Man's First Useful Art

By B. F. TILLSON • MEMBER, AIME

Mining may be defined as a general term for the working of valuable deposits of minerals, either organic or inorganic in origin, for their removal from the crust of the earth. Besides subsurface excavations, mining generically includes opencuts, clay pits and stone quarries, oil wells, sulphur wells, salt wells, placers, coal stripping, and the leaching of ore bodies.

The origin of the word "mine" or "mining" is a matter of conjecture. A Celtic origin has been suggested since the Irish word *mein*, or the Welsh *mwyn*, meant ore, but it seems to have come from an old French verb *mineor*, which meant to excavate, to make an underground passage as in the military approach to a fortification, sometimes called "sapping." Although not used by the Romans in that sense, it probably derived from the Latin word *mina*, a point; therefore that which projects and threatens. In Latin, *minae* means threats, and *minitare* or *minari* to threaten or drive cattle by threats, and the English derivative "minatory" means threatening.

The Romans used the word *cuniculi* for underground passages, like rabbit warrens, because *cuniculus* meant rabbit. In Caesar's "Gallic Wars" the Bituriges were said to be skillful in undermining fortifications by *cuniculi* because they had large iron mines, called *ferrariae* in which they used every kind of *cuniculus*. The Latin verb *fodere*, to dig, from which "fossil" is derived, and the noun *foding*, a digging, were used for our word "mine" but the substantive adjective, with the noun *fodina* omitted and understood, was the common usage: *aurariae* or *argentariae (argentifodina)* for gold or silver mines; *aerariae* or *ferrariae* for copper or iron mines.

The Romans also used the word *metallum* to mean not only metal but also a mine, mining operations, min-

---

From a talk given by Mr. Tillson to the AIME Student Chapter at The City College of New York.

eral, and ore. It was derived from the Greek *metallân*, to seek after, to prospect.

Mining, the digging for minerals, and the reasoning intent associated with it may have represented the dawn of civilization and man's superiority over other forms of life. Man surpassed animals when he developed the intelligence to make tools which he used to make or do something else.

Salt, as a necessity for every animal, was a mineral for which primitive man must have prospected and dug as he was forced to become migrant from a salt lick. Then flint for his weapons was mined in the Stone Age and was prospected for in depth because such flint in situ could be more readily and perfectly flaked into desired sharp-edged shapes than could the weathered flint on the surface. Obsidian or volcanic glass was a substitute for flint in the island of Melos, one of the Cyclades. But the limestone and chalk formations were prospected elsewhere for chert and flint.

In Belgium, a 2-ft cross-section shaft was sunk by primitive men 32 ft through gravel and sandstone to reach flint-bearing chalk. Such early flint mines are found near Worthing, England, where a pit 17 ft in diameter was sunk through 12 ft of chalk to a horizon of flint nodules; and from it radiated seven galleries 10 to 30 ft long, 2 to 3 ft high, and 4 to 7 ft wide. Various horizons of flint nodules were often passed through to find a preferred one.

Antlers were used for mining picks and shoulder or pelvic bones of large animals for shovels. Grease was burned in chalk or soapstone basins for illumination in extended galleries, until they were abandoned when the air became nonrespirable.

Then a new shaft was sunk near-by. Ventilation was possibly an accident when the workings of adjacent shafts happened to meet. Thereafter, surveying may have been introduced; for at Cissbury, County Sussex, England, six shafts in chalk are found connected by intricate workings with intervening pillar walls.

Primitive man also mined underground for pigments to paint his body and his pottery: red and yellow ochre (iron ore), black manganese wad, green malachite (copper ore), and vermilion cinnabar (mercury ore).

Although man probably first used flint pebbles found in stream beds and gravel banks, yet their selection and recovery was placer mining. Then he tunneled at flint horizons into cliffs, and later sank shafts to reach such horizons. So mining may be proposed as the first of man's useful arts. His first willful production of fire may have come from the striking together of flint and pyrite to cause sparks to ignite dried moss. The flaking and later the polishing of stones provided him with the tools to kill, skin, and dismember animals, for food and clothing; to chop and fashion wood for tillage, transport, and dwellings, and for weapons of offense and defense.

To duplicate stones of desired properties, man was forced to note their hardness, color, specific gravity, workability, and geologic associations. This was primitive mineralogy and geology. In the process of their discovery, mining, and beneficiation, man was led to develop the other fundamental engineering arts; even the first known map of 1300 B.C., on papyrus, shows a gold-mining district in Egypt. Ores of iron and copper were used as pigments to decorate pottery with colors which were dependent upon firing in an oxidizing or a reducing atmosphere. Suitable clays were mined. Gold was collected for ornaments by the Stone Age man. Copper was the first metal used to form tools for man because it occurred in large native masses, was harder and tougher than gold, and could be hardened by hammering. Its ductility and malleability permitted it to be hammered into useful forms.

The Mound Builders of America were of the Stone Age and left artifacts hammered from glacial-drift native copper from Lake Superior. Native silver occurs "welded" with some of the native copper. But Syria, Egypt, Asia Minor, and Cyprus also worked copper in 8000 B.C. About 6000 B.C. it was discovered that with a chimney draft or forced draft, copper could be melted in a wood fire and then cast in stone, sand, or clay molds. Normal altar or cooking fires would give a temperature of only 932F, and 1981F is required to melt copper, and 1634F for 20 per cent tin bronze. In that century it was discovered that the oxidized ores of copper could be reduced to the metal by smelting operation when lime or other fluxes were present in the fire.

The fortuitous association of tin ores with those of copper produced a harder copper, which we call bronze, and by 5000 B.C. the oxide of tin (stream tin) was used as a flux to make such bronze in Egypt and Mesopotamia. Iron did not become a metal of utility until about 1000 to 1200 B.C. in Egypt and the Aegean.

Thus the art of metallurgy and the Civilization of Metals was an outgrowth of that interest in minerals which was stimulated by the mining art. Ten metals and about eighty different minerals and rocks were known to the early Egyptians and all but four are known to have been used.

Development of mining practices and plants has been responsible for many of the mechanical and electrical arts. The age of steam power plants and steam engines started with the boilers and mine pumps of Capt. Thomas Savery in 1698, Thomas Newcomen in 1705, and James Watt in 1768 and 1774.

Even the predecessor of radar was the short-wave radio reflection and refraction researches used in seeking ore bodies.

Coal is one of the extensive mineral resources dependent upon mining. Although not mentioned in the Doomsday Book of 1085, Britons made slight use of it for domestic fuel in pre-Roman Britain; it was not used for manufacture (glass) until 1609, and for coke in iron foundries until 1745. Its great use was promoted by the development of the steam engine for power.

Thereby coal became the chief factor in bringing slavery to an end, because it made slavery uneconomic. It made the productive energy of a free man 22,700 times that of a slave. The following approximate factors lead to such a conclusion: two pounds of coal produce steam which will develop 1 hp-hr; 1 hp-hr equals 10 man power; the productive capacity of one free man averages that of 3½ slaves; average production of coal in the United States for 1940 per man shift employed (8-hour shift or less) was 5.19 tons or 10,380 lb, equal to 5190 hp-hr or 51,900 free man-power hours or 6488 free man-power shifts of 8 hr, equal to 22,706 slave shifts of 8 hr or 15,138 slave shifts of 12 hr.

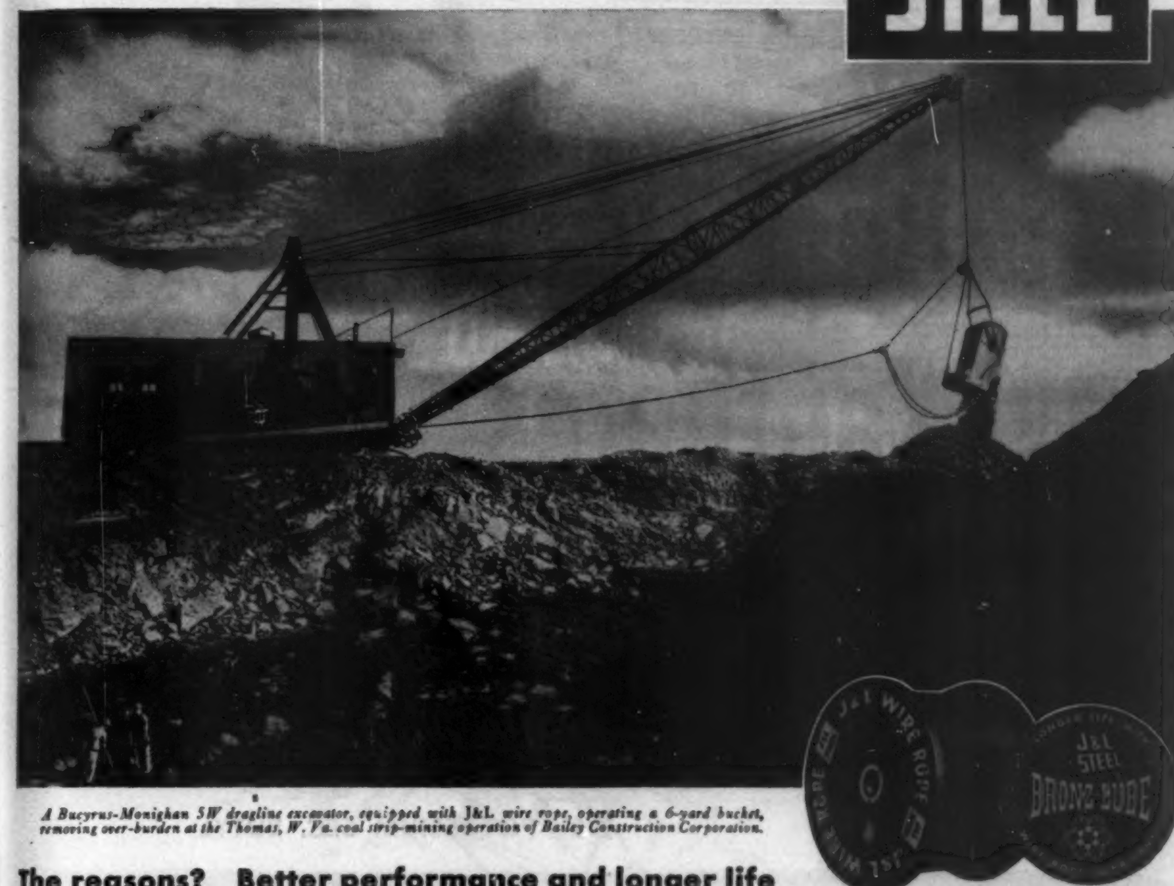
From the dawn of civilization the mining of ore has played a leading part in the drama of humanity, although maleficent as well as beneficent uses have been made of the materials mined.

BAILEY CONSTRUCTION CORPORATION

—scientific coal strip-mine operator—

prefers J&L *Precisionbilt* Wire Rope

J&L STEEL



A Bucyrus-Monighan 5W dragline excavator, equipped with J&L wire rope, operating a 6-yard bucket, removing over-burden at the Thomas, W. Va. coal strip-mining operation of Bailey Construction Corporation.

The reasons? Better performance and longer life assured by J&L wire rope engineering service.

Bailey Construction Corporation, organized by Mr. Harold L. Bailey, noted coal mining engineer of Schuylkill Haven, Pa., has two coal strip-mining operations under way in West Virginia. One near Thomas, in Tucker County, has four working pits now in operation. The other, soon to be in full production, is at Lorado in Logan County.

On every piece of Bailey's modern equipment . . . draglines, shovels, bulldozers . . . you'll find J&L *Precisionbilt* Wire Rope in a variety of sizes and types, each designed to do a particular job.

One of the basic principles of all Bailey operations is this: *Use only the very best of equipment—and use it properly.*

That's why Bailey has standardized on J&L *Precisionbilt* Wire Rope. Says Mr. Bailey: "Our experience has proved that the combination of J&L Wire Rope and J&L engineering service gives us better performance, longer rope life and lower over-all costs."

There's a growing list of top flight companies engaged in earth-moving, oil production, lumbering, general manufacturing and transportation, that use J&L Wire Rope *exclusively!* Like the Bailey Construction Corporation, they find that J&L *Wire Rope* and J&L *Engineering Service* work together to cut costs and increase profits.

If you are interested in getting the complete details on J&L *Wire Rope Engineering Service* and what it can do for you, why not clip the coupon?

Jones & Laughlin Steel Corporation
413 Jones & Laughlin Building
Pittsburgh 19, Pa.

Please send us a free copy of your new booklet, "J&L Wire Rope Engineering Service."

Name____________________

Company Name____________________

Address____________________

JONES & LAUGHLIN STEEL CORPORATION

From its own raw materials, J&L manufactures a full line of carbon steel products, as well as certain products in OTISCOLOY *and* JALLOY *(hi-tensile steels).*

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

Letters to the Editor

(*Continued from p. 28, Sect. 1*)

it examined by the late W. D. McMillan, of Vancouver, and by Orville Young. For some time I had copies of these reports and some samples of fine book mica up to sizes which cut 10 by 12 in. Young stated in his report that similar books had been taken out which cut clear sheets 24 by 36 in. in size, all iron free, clear, and of most excellent insulating quality. Photographs of open faces in the sides of open cuts 20 to 30 ft in depth in the pegmatite showed the books to be scattered closely through the mass. In one instance, Young estimated that 40 per cent of the face was books of similar mica up to 8 by 10 in.

The ground may be reached from Golden, which is on the Canadian Pacific R. R., by canoe or poling boat down stream through Kinbasket Rapids, which are not dangerous for a skilled canoe or boatman. Return trip is made down stream through a series of smaller rapids to Revelstoke, from whence the boat or canoe may be returned to Golden by rail. The Canadian government started to build a highway around the Big Bend but work was stopped during the war and I do not know if it has yet been completed.

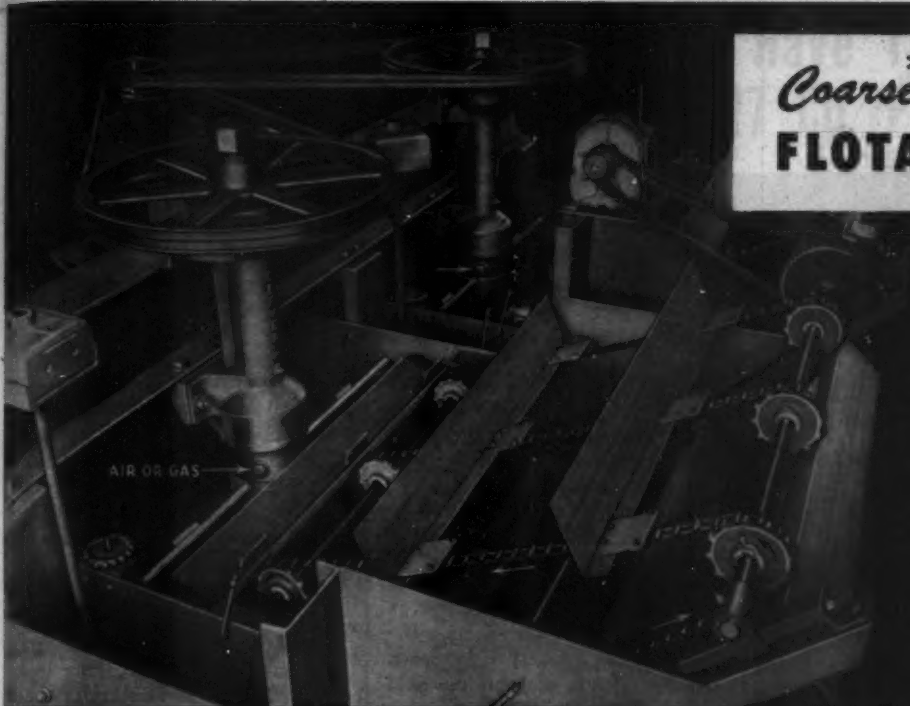
Climatic conditions are not good; much cold and snow in the winter, lasting until late spring and starting again early in the fall of the year. However, with proper preparation, the deposit could be worked the year 'round, shipping the product in the summer months. It was reported that on one rim where erosion had taken place, much material had fallen to the foot of the cliff so that there were many hundred tons of book mica piled up, the groundmass of pegmatite having been shattered by the fall. Anyone making a trip to inspect this deposit will not be disappointed.

Comment on U. S. Smelting Issue

J. D. Forrester compliments and corrects the October M&M:

The October 1948 issue of *Mining and Metallurgy* splendidly portraying activities of the U. S. Smelting Refining and Mining Co., proved to be especially interesting to me. On page 543, a picture, "Men of Bingham's

(*Continued on p. 44*)



Coarse * COAL FLOTATION

Working directly with the Bureau of Mines Coal Preparation Section, and with large coal companies engaged in solving the problem, Denver Flotation Engineers designed a * Flotation Machine which does an effective job of coal cleaning as will be noted in the tabulations below from Bureau of Mines Report of Investigations 4306, July 1948.

Marketable results are obtained on varying types, grades and sizes of coal fractions.

with DENVER "SUB-A" FLOTATION MACHINES

PROBLEM • **Treating coal fractions from 1/16"-0. Two objectives are sought—**

1) *to save marketable grade of coal in these sizes and*

2) *eliminate stream pollution from wasted slurry water.*

These coal fractions cannot be satisfactorily cleaned by "gravity" methods. With flotation remaining as the most acceptable solution, a prime consideration is that the flotation machine used must be capable of handling both coarse and fine sizes effectively. The rapid rising, dense agglomerate type "matte" coal concentrate must be removed and dewatered in large volume.

SOLUTION • No commercial flotation machine can treat both coarse and fine sizes so effectively as the Denver "Sub-A." This selective feature plus its extreme mechanical and metallurgical flexibility makes it the logical choice for coal cleaning work.

Removal and dewatering of the dense agglomerated "matte" concentrate was accomplished with special "deep-digging" punched plate rakes which carry the 7"-8" coal matte up the spitzkasten allowing surplus water to drain back in the pulp through the perforated rakes. Further dewatering is carried out in a wedge bar compression screw conveyor. Surplus water returns via middling feed pipe to the Denver "Sub-A" Flotation cell for re-use, thus eliminating surplus slurry water.

	SCREEN SIZE, MESH	FEED		CLEANED COAL		REFUSE		DISTRIBUTION, %		Reagents, lbs. per ton feed
		Weight, percent	Ash, 1* percent	Weight, percent	Ash, 1* percent	Weight, percent	Ash, 1* percent	Cleaned Coal	Refuse	
MINE I *	10 to 14	18.8	11.9	23.0	6.2	9.1	31.6	77.6	22.4	Kerosene, 3.27
	14 to 35	51.4	19.1	56.0	7.6	31.9	65.3	80.1	19.9	B-23 Frother, 0.24
	35 to 100	23.3	40.3	17.0	13.4	35.6	81.8	60.7	39.3	Pine Oil, 0.11
	Through 100	6.5	58.3	4.0	19.3	23.4	84.0	39.7	60.3	
	Composite through 10	100.0	25.2	100.0	8.7	100.0	72.5	74.1	25.9	
MINE II *	10 to 35	64.2	10.5	58.2	3.4	54.0	50.7	85.0	15.0	Kerosene, 3.46
	35 to 100	22.6	10.5	26.9	4.6	22.2	66.2	90.4	9.6	B-23 Frother, 0.26
	Through 100	13.2	12.8	14.9	6.3	23.8	64.8	88.9	11.1	Pine Oil, 0.20
	Composite through 10	100.0	10.8	100.0	4.2	100.0	57.5	87.6	12.4	

1*—*Moisture free basis*

CONSULT WITH YOUR DENVER "FLOTATION ENGINEERS"

"The firm that makes its friends happier, healthier and wealthier"

DENVER EQUIPMENT COMPANY 24 HOUR SERVICE

DENVER EQUIPMENT COMPANY
P. O. BOX 5268 • DENVER 17, COLORADO

DENVER • NEW YORK CITY • CHICAGO • TORONTO • VANCOUVER • MEXICO CITY • LONDON • JOHANNESBURG • RICHMOND, AUSTRALIA

Letters to the Editor

(Continued from p. 42, Sect. 1)

Stormy Period," shows my father in the lower-right. His name should be given as J. G. Forrester; perhaps you will wish to keep the record straight. He was about 27 years old at the time the picture was taken and had been associated with the Holdens in Cleveland, Ohio, before going to Bingham.

Russia Works Old Silver Mines for Uranium

F. Lynwood Garrison recalls an early visit, while a student, to Joachimsthal, where the Russians are now mining uranium:

In the July number of *The Reader's Digest* there was an article by Thomas M. Johnson about Soviet slaves digging uranium in the Erzgebirge, a range of low mountains dividing Bohemia (Czechoslovakia) from Saxon Germany. This is probably the most famous, or even classic, metal mining region in Europe during the past 300 years. It was the home of Agricola. On the northern flank of these hills lies the little town of Freiberg and its famous Royal Saxon Mining Academy where economic geology as a separate science had its beginnings with von Cotta, as also did blowpipe analysis have its inception with Plattner's great system for mineral identification. Not a few of the older generation of American mining engineers had their technical education in this ancient institution when technical institutions of similar character were few and far between in the United States.

The Erzgebirge region is essentially one of silver mining. The most important and certainly the best-known mine in this district is at the little town of Joachimsthal on the southeastern side or slope of the Erzgebirge in Bohemia.

When a student in Europe, I had the opportunity of visiting this mine and I realized even then that this was an interesting and historical spot.

The Joachimsthal mine (the main shaft then was 1600 ft in vertical depth) was equipped with old-fashioned machinery which appeared to jog quietly along producing silver ores as it had probably done since the year 1527 when Agricola became the town physician there. It was from this old mine that the Curies obtained the ore in which they discovered the element radium.

The ores in this mine were mainly argentite, stephanite, pyrargyrite, proustite and considerable pitchblende (uraninite). I was not then familiar with pitchblende and my curiosity was aroused, little dreaming it would some day be an ore setting the world by the ears. I was then told it was not of much importance, being mined in small quantities and often thrown on the waste dumps; its only commercial value was for coloring china or other ceramics for which Bohemia was famous. All these ores occur in what were called fissure veins two or three feet in width with a pay streak of three or four inches. All the ores were crushed, hand-sorted, and concentrated on shaking tables before being shipped to the smelters.

The existence of small quantities of pitchblende and other uranium minerals in the mines of that region has long been known. Dana in his great "System of Mineralogy" mentions their presence at Marienberg and Schneeberg in Saxony, at Pribram in Bohemia, and Rezbánya in Hungary. Lindgren states it is found at Schneeberg, and more abundantly in somewhat similar veins at Joachimsthal. Deposits like these also occur at Annaberg on the Saxon side of the Erzgebirge; Johanngeorgenstadt was also a considerable producer of uranium ores. It seems doubtful to me that the Russians can ever recover enough uranium from the depleted mines in central Europe to justify the cost, effort, and brutality they are expending there for that purpose.

"Hot Popper Process"

Jet piercing is poor nomenclature for the new process to those who know their drilling methods writes W. B. Lang, of the Geological Survey at Washington, D. C.:

In reading J. H. Zimmerman's interesting article on "Jet-Piercing Process for Blastholes" in the May M&M, I found myself finishing a column of the paper before I gained a clue to the type of drilling under discussion. I was further confounded by a later statement that "In view of the most recent discoveries, the name 'jet-piercing' is being adopted as approved terminology."

Use of the terms "jet drilling" or "wash drilling" refers to an old estab-

lished method of drilling unconsolidated sediments by means of a directed stream of water assisted by a chopping bit. It is a method almost as old as the pressure pump itself and use of these terms promptly recalls this type of drilling to the mind of those informed on drilling methods. Had the writer used "flame drilling" for this unique process of applying an intense spot flame to spall off rock of low thermal conductivity no confusion could have arisen.

In view of the ever-increasing volume of nomenclature for complex technical apparatus it seems highly desirable to exercise due care in the selection of such terms as will adequately cover the nature or purpose of the equipment so that the reader may thus be aligned in the course of thought he is to follow. I believe I should have caught on more quickly if Mr. Zimmerman had borrowed the practice of modern youth and simply called it a "hot popper process"!

Telephone Value to Mines Seen Early

Dorothy Bolles, of AT&T, must have seen our comment on the first telephone used in a mine in our August issue, for she writes:

I am quoting below the few references to the use of telephones in mines before 1880 that I've been able to locate quickly. In addition, someone in Nova Scotia claims the telephone was so used there at least by early 1878, but our Historical Library hasn't satisfied itself that it is a true claim.

In "Exploring Life" on p. 149, T. A. Watson says: "One of the interesting things I did early in 1878 was to install telephones in a mine for the first time. Gardiner Hubbard and Thomas E. Cornish, our agent in Philadelphia, were with me on that important occasion. It was a deep and very wet coal mine on the Reading Railroad, but by running covered wires down the shaft, we had no difficulty in establishing communication between the underground workings and the mine office. It worked so well the owners ordered a permanent installation. I made no change in the telephones for underground use. In wet mines the regular instruments were installed in watertight boxes."

A Report of Bell's illustrated talk to the Society of Telegraph Engineers

(Continued on p. 46)

Letters to the Editor

(Continued from p. 45, Sect. 1)

(London?) on Oct. 31 in "Nature," Nov. 15, 1877, tells various incidents and describes early experiments: "In a lecture on the 8th inst. at Glasgow, Professor Bell, referring to the use of the telephone in mines, pointed out how the instrument might be of the greatest service in determining whether the ventilation of a mine was perfect or not; for by listening to the telephone, if the mine was in good order, a little sound could be heard every moment."

Coke Output Gained 26% in 1947

The coke industry is considered to have held a leading position in the 1947 production race, now that all contributing factors have been averaged together. According to the Bureau of Mines, total coke production for 1947 was up 26 per cent over that for 1946; whereas, the figure of industry in general, for the some comparison, was only 10 per cent. This was accomplished in oven and beehive plants, in

(Continued on p. 50)

MANUFACTURERS
NEWS • *Equipment—Bulletins—Personals*

Marion Shovel

A 45-cu. yd. dipper has been installed on a Marion 5561 shovel in operation at The Hanna Coal Co. mine, in southeastern Ohio's coal stripping fields, in an experiment to prove the "economic ultimate" of modified armor plate steel in power shovel dipper design and construction. If the experiment is a success, a 5-cu.yd. load of earth and rock will be able to "hitch-hike" a free ride every minute as the shovel strips away overburden to uncover seams of coal lying as deep as 80 ft. under the earth's surface. Prior to two years ago, a 35-cu.yd. dipper had been the world's largest. Then Marion developed a 40-cu.yd. dipper, and nine of the big 40-yd. dippers have been built and put into service. With their practicability fully proved and with field experience on hand to indicate that the new five-yard increase in capacity may be practical, the Marion and Hanna companies jointly are experimenting to "make the new steels work a little harder" and learn whether a 45-yd. will prove as practical as the 40-yd. dipper.

Personals

J. R. Fulton has been appointed manager of mining sales in the Westinghouse Industrial Sales Department.

Link-Belt Co. announces that *R. E. Whinrey*, formerly superintendent, has been appointed to the newly created position of assistant general manager of the Link-Belt Dodge plant in Indianapolis. *L. C. Heinlein*, formerly assistant superintendent, succeeds Mr. Whinrey. The Dodge plant is devoted to the manufacture of Link-Belt ball and roller bearings of both mounted and unmounted types.

Wilkinson & McClean, Ltd., of Calgary, Edmonton, and Lethbridge, Alta., Canada, will be distributors for Bucyrus-Erie blast-hole drills, prospecting drills, and bit dressers. Well known in the mine, quarry, and excavating industries, they will also handle excavators, electric quarry and mining shovels, and walking draglines.

Appointment of *C. S. Gotwals* as quality manager of all *SKF Industries, Inc.*, plants is announced by the Philadelphia ball and roller bearing firm. Charles R. Scott, Jr., succeeds Mr. Gotwals as superintendent. W. F. Shedinger will direct operations of the machining division in addition to his duties as head of the ball division.

Bulletins

Magnetic Pulleys. A complete description of features and applications of electromagnetic pulleys and Alnico magnetic perma-pulleys for automatic separation of ferrous and nonferrous materials is given in two new 8-page catalogs issued by Dings Magnetic Separator Co., Milwaukee. Both catalogs were prepared as a ready guide for magnetic separator users to help determine the type and size of magnetic pulley most suitable for their specific requirements. Catalog C-1001A describes the purpose, operation principle and advantages of Dings electromagnetic pulleys, including the design features of air-cooled pulleys, solid type pulleys and waterproof, greaseproof or heatproof special pulleys. Catalog C-1007A details the features of the newly developed Perma-Pulley.

New Boom Jumbo

The new **Boom Jumbo** designed by the Ingersoll-Rand Co. for modern high-speed tunnel driving features maximum rigidity, air-powered boom from lowest to highest position at the touch of a lever, centralized controls, and positive lock. It can be set up quickly and is easy and safe to operate. The Boom Jumbo is constructed of seamless steel tubing which serves to carry air and water to the drills. For further information, write to the above company.

Engineering Societies Personnel Service, Inc.

New York—8 West 40th St., Zone 18. *San Francisco—57 Post St.*
Detroit—100 Farnsworth Ave. *Chicago—84 East Randolph St., Zone 1*

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of these advertisements, to pay a placement fee, established to maintain an efficient, nonprofit service.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary.

All replies should be addressed to the key numbers indicated and mailed to the New York office.

A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

Men Available

MINERAL TECHNOLOGIST, 28, married, one child, B.S. degree in geology and mineralogy. Advanced training in petrographic methods. Four years' experience nonmetallic mineral technology. Desires position in research or development with progressive organization. Employed; available 30 days. M-405.

MINING GEOLOGIST, M. S. Professional engineer. Nine years' experience all phases underground mining operations, property examination, valuation, geological investigations and technical reports. Prefers position business or administrative branch of mining. Available one month's notice. Prefers eastern United States. M-406.

Positions Open

MINING ENGINEERS AND METALLURGISTS. (a) Metallurgist-Mill Foremen, experienced, college graduates. Knowledge Spanish. Three-year contract. Starting salary, $5000 plus bonus and living quarters. Single preferred; if married, single status for six months. Transportation paid. (b) Junior Metallurgists, recent graduates, with knowledge of Spanish desirable, but not essential to start. Starting salary, $3000 plus bonus and living quarters. Single. Transportation paid. (c) Junior Mine Engineers, recent graduates, competent as underground surveyors and draftsmen. Three-year contract. Starting salary, $2700 plus bonus and living quarters. Single. Transportation paid. Bolivia. Y988.

RECENT GRADUATE MINING ENGINEER, trainee, 24-26, to work in purchasing department of large manufacturer, particularly in purchasing of extracted materials, i.e., coal, limestone, iron ore, etc. $3600. New York, N. Y. Y1025(b).

ENGINEERS. (a) Mining Engineers, experienced in underground work, to act as mine foremen, Bolivia. $4200-$4800. Three-year contract. Married men preferred. Spanish helpful. (b) Geophysicist, capable of organizing and carrying on complete exploration program in Bolivia under supervision of geological department. Three-year contract. Salary open. (c) Junior Engineers, recent graduates, for engineering, survey, sample work in Bolivia, and to act as mine shift bosses. $3300. Three-year contract. Excellent chance for advancement. Y1027.

ENGINEERS. (a) Assistant Mine Foreman, thoroughly experienced underground. Must speak Spanish. Single status for six months. $3600 to start. (b) Mill Shift Boss, recent graduate, single, who has specialized in metallurgy, and who can do test work. Should be interested in research. Spanish an asset, but not essential. $2700 to start, plus room and board. Central America. Y1119.

METALLURGIST to conduct and supervise ore dressing, laboratory experimenting and concentration of fine ores by gravity, flotation and volatilization technique. Three-year contract, three weeks' vacation each year, plus living quarters, medical and hospital service. Transportation to Bolivia for applicant, wife and one child paid. Y1135.

MINE SUPERINTENDENT with experience in cut and fill stoping, mine development, shaft sinking and maintenance. Must have fair working knowledge of Spanish and ability to handle labor. Salary, approximately $9600. Apply by letter giving age, experience, etc. Latin America. Y1320.

ENGINEERS. (a) Mill Superintendent with considerable experience, to take charge of 800-ton lead-zinc flotation plant. $6000-$7000. Bolivia. (b) Mine Superintendent, 35-45, experienced underground, cut and fill shrinkage methods. Knowledge of Spanish desirable plus executive ability. Salary open. South America. Y1505.

MINING-METALLURGICAL ENGINEER for development of zinc, lead and copper sulphide ores containing impurities of antimony and bismuth. Must be capable of directing layout of mining operations, planning transportation, setting up processing plant, ordering machinery, putting plant into operation, and supervising entire operation from mining to production of metals and their derivatives, such as zinc oxide, etc. Development will probably be along primitive lines at first, and considerable ingenuity will be required. Housing provided. Three-year contract. India. Y1516.

PROCESS METALLURGIST for process development and semi-works production of metals by chemical or electrofurnace reduction. Write stating qualifications, experience and salary expected. Location, New Jersey. Y1646.

MINING METALLURGIST with process experience covering uranium ores, to evaluate field reports and plan development. $6000-$7000. South America. Y1907.

METALLURGIST, 25-30, graduate, with welding experience covering stainless steels, to analyze production difficulties, improve welding methods and procedures, and do general development work covering fabrication. Salary, $3640-$5200 a year. Location, New Jersey. Y1913.

ENGINEERS. (a) Mining Engineer, young, preferably with two to five years' experience for work at lead mine. (b) Engineer, young, for work in concentrating plant. Argentina. Y1925.

RESEARCH METALLURGIST, 30-40, graduate, with non-ferrous smelting and refining experience, to supervise development of hydro-metallurgical pyrometallurgical and electrolytic refining methods. Salary, $4200-$4800 a year. Location, northern New Jersey. Y1926.

MINING ENGINEER, young, with two to five years' experience and with good knowledge of mechanized coal mining. Will function as assistant to executive in New York office and as liaison between mines and office. Salary open. New York, N. Y. Y1943.

MINE SUPERINTENDENT, graduate mining engineer, executive type, ten years' experience, four of which must have been in coal mining; other experience in metal mining will be acceptable where coal mining methods have been used. Will be responsible for laying out plans, developing mechanization methods, etc. $6000-$7500. Wyoming. Y1949S.

DESIGN DRAFTSMAN with at least five years' structural and metallurgical equipment design and layout experience, to design, lay out and detail structures, mining, conveying, and milling facilities for mining company. $4000-$5000. New York, N. Y. Y1968.

(*Continued from p. 46*)

which the total quantity of coal carbonized in 1947 nearly equaled the 1944 record.

Heavy demands for coke as metallurgical fuel, and increase in the number of man-hours worked, were some of the factors that helped boost production rates. On the dark side of the picture, coke output was low considering the amount of coal used, since the coal was of poor quality and the ovens have been deteriorating.

Operations proceeded at a fairly uniform rate during the year, except toward the end when production reached an all-time high through the additional ovens put into service. Had more good coking coal been available, output no doubt would have been even greater.

NEW TECHNICAL BOOKS

Engineering Societies Library

New books can be borrowed by AIME members in the United States or Canada for a nominal fee. Bibliographies, photostats, microfilm, and translations can also be supplied.

Geology Applied To Building and Engineering. By A. Bray. Sir Isaac Pitman & Sons, Ltd., London. 1948. 196 p., illus., diagrs., maps, tables, 8¾ x 5½ in., cloth, 18s.

Of interest to students, buildings, architects, and civil engineers, this volume deals with raw materials extensively used in the building industry. A short introductory chapter on the general principles of geology is given. Other chapters deal with quarrying and mining methods, surface deposits and sites, and the formation, types, and uses of a wide variety of rocks and minerals.

Report on Mining Subsidence. Institution of Municipal Engineers, 84 Eccleston Square, London, S.W.1, 1947. 80 p., diagrs., maps, tables, 9½ x 6 in., paper, 5s.

Summarized reports are given of damage in selected British coal fields, including descriptions of fields, types of damage, and remedial measures. Brief general notes on subsidence, stowage, structural precautions, etc.,

(*Continued on P. 51*)

Services

that have at least one member on their staffs.
inch, $25 payable in advance.

Drilling
Geophysicists
Management
Metallurgical
Reports
Valuations

New Books

(*Continued from p. 50*)

are also given. Three papers relating to various aspects of the subsidence problem are appended together with a memorandum on the law relating to subsidence due to mineral workings.

Salt, the Fifth Element. By G. L. Eskew. J. G. Ferguson & Associates, 122 So. Michigan Ave., Chicago, 1948. 239 p., illus., 8½ x 5½ in., cloth, $3.

This volume presents in an informal manner the history, sources, production, and uses of salt, touching also upon the commercial and transportational aspects of salt distribution. The persons and places of importance in the development of the salt industry are noted in descriptive passages and anecdotes.

Surveying. By W. Norman Thomas. 4th ed. Longmans, Green and Co., New York; Edward Arnold & Co., London, 1948. 564 p., illus., diagrs., charts, maps, tables, 8¾ x 5½ in., cloth, 30s., $7.50.

This standard British text describes in detail the instruments and procedures used for all kinds of surveying work: levelling, plane table surveying, curve ranging, earthwork calculations, triangulation, hydrographic, photographic and aerial surveying. Particular attention is paid to the adjustment of instruments, and a new chapter on the adjustment of errors has been added in this edition.

One-inch card is $40 per year; half inch, $25; payable in advance.

Advertisers' Index